General Specifications

Item	Specification
Lubricants and Sealants	
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP	WSS-M2C153-H
Gasket and Trim Adhesive F3AZ-19B508-AA	ESE-M2G52-A
Pipe Sealant with Teflon® D8AZ-19554-A	WSK-M2G350-A2
Silicone Gasket and Sealant F7AZ-19554-EA	WSE-M4G323-A4
Metal Surface Cleaner F4AZ-19A536-RA	WSE-M5B392-A
Engine	
Displacement	3.8L
Number of cylinders	6
Bore	96.8325 mm (3.81 in)
Stroke	86.0 mm (3.39 in)
Firing order	1-4-2-5-3-6
Oil pressure (hot 2,500 rpm)	40-125 psi
Oil capacity	5 quarts w/filter change
Compression ratio	—
Cylinder Head and Valve Train	
Cylinder head gasket surface flatness	0.18 mm (0.007 in)
Combustion chamber volume	61.5-64.5 cc
Valve arrangement (front to rear)	—
Valve guide bore diameter	7.015-7.044 mm (0.276-0.277 in)
Valve stem diameter — intake	6.955-6.988 mm (0.2738-0.2751 in)
Valve stem diameter — exhaust	6.929-6.962 mm (0.2728-0.2741 in)
Valve stem diameter — oversize (intake)	9.075-9.055 mm (0.3573-0.3565 in)
Valve stem diameter — oversize (exhaust)	9.063-9.043 mm (0.3568-0.3560 in)
Valve stem diameter — oversize (intake)	9.456-9.436 mm (0.3723-0.3715 in)
Valve stem diameter — oversize (exhaust)	9.444-9.424 mm (0.3718-0.3710 in)
Valve stem-to-guide clearance — intake	0.020-0.069 mm (0.045-0.090 in)
Valve stem-to-guide clearance — exhaust	0.038-0.083 mm (0.0015-0.0033 in)
Valve head diameter — intake	47.27 mm (1.86 in)
Valve head diameter — exhaust	37.1 mm (1.46 in)
Valve face runout	0.05 mm (0.002 in)
Valve face angle	45.675 degrees
Valve seat width	1.5-2.0 mm (0.06-0.08 in)
Valve seat runout (T.I.R.)	0.076 mm (0.003 in)

Valve seat angle	44.75 degrees
Valve spring free length	—
Valve spring squareness	—
Valve spring compression pressure — valve open (without damper)	1000 N (224 lbs) @ 29.2 mm (1.16 in)
Valve spring compression pressure — valve closed (without damper)	350 N (79 lbs) @ 40.7 mm (1.62 in)
Valve spring installed height	40.7 mm (1.62 in)
Valve spring installed pressure	—
Rocker arm ratio	1.73
Hydraulic Lash Adjuster	
Diameter	22.195-22.212 mm (0.8738-0.8745 in)
Clearance-to-bore	0.018-0.068 mm (0.0007-0.0027 in)
Service limit	0.127 mm (0.005 in)
Hydraulic leakdown rate	[a]
Collapsed lash adjuster gap	—
Camshaft	
Theoretical valve lift @ 0 lash — intake	11.30 mm (0.45 in)
Theoretical valve lift @ 0 lash — exhaust	11.47 mm (0.45 in)
Lobe lift — intake	6.53 mm (0.257 in)
Lobe lift — exhaust	6.57 mm (0.259 in)
Allowable lobe lift loss	0.127 mm (0.005 in)
Journal diameter	52.082-52.108 mm (2.0505-2.0515 in)
Camshaft journal bore inside diameter — No. 1	55.689-55.664 mm (2.192-2.191 in)
Camshaft journal bore inside diameter — No. 2 and No. 3	55.308-55.283 mm (2.177-2.176 in)
Camshaft journal bore inside diameter — No. 4	55.684-55.664 mm (2.192-2.191 in)
Camshaft journal-to-bearing clearance	0.025-0.076 mm (0.001-0.003 in)
Runout	0.05 mm (0.002 in) runout of No. 2 or No. 3 relative to No. 1 and No. 4
End play	0.025-0.150 mm (0.001-0.006 in)
Cylinder Block	
Cylinder bore diameter	96.813 mm (3.81 in)
Cylinder bore maximum taper	0.050 mm (0.002 in)
Cylinder bore maximum out-of-round	0.050 mm (0.002 in)
Main bearing bore inside diameter	68.905 mm (2.713 in) 68.885 mm (2.712 in)
Camshaft bearing bore inside diameter — intake	47.097 mm (1.8542 in) max. 47.072 mm (1.8532 in) min.
Camshaft bearing bore inside diameter — exhaust	39.739 mm (1.5645 in) max. 39.714 mm (1.5635 in) min.
Head gasket surface flatness	0.08 mm (0.003 in) in 152.0 mm (6.00 in)
Crankshaft	
Main bearing journal diameter	63.983-64.003 mm (2.5190-2.5198 in)

Main bearing journal maximum taper	0.008 mm (0.0003 in) per 25 mm (1.0 in)
Main bearing journal maximum out-of-round	0.008 mm (0.0003 in) max. in 45 degrees, 0.015 mm (0.006 in) total
Main bearing journal-to-cylinder block clearance — desired	0.025-0.035 mm (0.001-0.0014 in)
Main bearing journal-to-cylinder block clearance — allowable	0.013-0.058 mm (0.0005-0.0023 in)
Connecting rod journal diameter	58.682-58.702 mm (2.3103-2.3111 in)
Connecting rod journal maximum taper	0.008 mm per 25 mm (0.0003 in per in)
Connecting rod journal maximum out-of-round	0.008 mm (0.0003 in) max. in 45 degrees, 0.015 mm (0.0006 in) total
Crankshaft maximum end play	0.10-020 mm (0.004-0.008 in)
Piston and Connecting Rod	
Piston diameter — code red	96.795-96.782 mm (3.8108-3.8103 in)
Piston diameter — code blue	96.808-96.795 mm (3.8113-3.8108 in)
Piston diameter — code yellow	96.821-96.808 mm (3.8118-3.8113 in)
Piston-to-cylinder bore clearance (undercoated clearance)	0.018-0.044 mm (0.0007-0.0017 in)
Piston ring end gap — compression (top, in gauge)	0.17-0.33 mm (0.0067-0.013 in)
Piston ring end gap — compression (bottom, in gauge)	0.3-0.55 mm (0.0118-0.0217 in)
Piston ring end gap — oil ring (steel rail, in gauge)	0.15-0.65 mm (0.0059-0.0256 in)
Piston ring groove width — compression (top)	1.54-1.52 mm (0.0606-0.0598 in)
Piston ring groove width — compression (bottom)	1.54-1.52 mm (0.0606-0.0598 in)
Piston ring groove width — compression (oil)	3.05-3.03 mm (0.1200-0.1193 in)
Piston ring width — compression (top and bottom)	1.460-1.490 mm (0.0575-0.0587 in)
Piston ring width — compression (oil)	Side seal — snug fit
Piston ring-to-groove clearance (1st and 2nd ring)	0.030-0.080 mm (0.0012-0.0032 in)
Piston pin bore diameter	22.94-22.98 mm (0.9032-0.9047 in)
Piston pin diameter	23.000-23.003 mm (0.9055-0.9056 in)
Piston pin length	63.55-63.05 mm (2.5096-2.4823 in)
Piston pin-to-piston fit	0.011-0.018 mm (0.0004-0.0007 in)
Piston-to-connecting rod clearance	—
Connecting rod-to-pin clearance	Press fit 8 kilonewtons (1,800 lbs)
Connecting rod pin bore diameter	—
Connecting rod length (center-to-center)	154.66-154.74 mm (6.0890-6.0921 in)
Connecting rod maximum allowed bend	0.04 per 25 mm (0.0016 per in)
Connecting rod maximum allowed twist	0.059 per 25 mm (0.002 per in)
Connecting rod bearing bore diameter	61.635-61.655 mm (2.4266-2.4274 in)
Connecting rod bearing-to-crankshaft clearance	0.025-0.035 mm (0.001-0.0014 in)

— desired	
Connecting rod bearing-to-crankshaft clearance — allowable	0.022-0.069 mm (0.00086-0.0027 in)
Connecting rod side clearance	0.11-0.49 mm (0.0047-0.0193 in)
Balance Shaft	
Journal diameter	52.108-52.082 mm (2.0515-2.0505 in)
Bore inside diameter	55.689-55.664 mm (2.192-2.191 in)
Maximum runout	0.025 mm (0.001 in)
End play	0.075-0.200 mm (0.003-0.008 in)

[a] 20-200 seconds to leakdown 3.18 mm (0.125 in) with 225 Newtons (50 pounds) load and tappet filled with leak-down fluid.

Torque Specifications

Description	Nm	lb-ft	lb-in
EGR transducer bracket-to-intake manifold bolts	10	—	89
Ignition coil-to-intake manifold bolts	6	—	53
Water outlet tube-to-intake manifold stud bolt	10	—	89
EGR tube-to-EGR valve nut	40	30	—
Water outlet tube-to-front water pump bolt	10	—	89
Fuel supply manifold bolts	10	—	89
LH valve cover-to-cylinder head bolts	10	—	89
LH valve cover-to-cylinder head stud bolts	10	—	89
EGR tube-to-exhaust manifold nut	40	30	—
RH valve cover-to-cylinder head bolts	10	—	89
RH valve cover-to-cylinder head stud bolts	10	—	89
Coolant recovery reservoir-to-cylinder head stud bolts	10	—	89
Coolant recovery reservoir-to-bracket bolts	5	—	44
Crankshaft pulley bolt	160	118	—
Camshaft position sensor bolts	3	—	27
Camshaft synchronizer-to-front cover bolt	25	18	—
Front cover-to-cylinder block bolts	25	18	—
Radiator fan shroud-to-radiator bolts	9	—	80
Camshaft thrust plate-to-cylinder block bolts	12	9	—
Camshaft synchronizer drive gear-to-camshaft bolt	45	33	—
Timing chain tensioner-to-cylinder block bolts	12	9	—
Exhaust manifold-to-cylinder head nuts	33	24	—
Power steering pump bracket-to-water pump nuts	20	15	—
Power steering pump bracket-to-generator bracket bolts	20	15	—
Generator bracket-to-cylinder head bolts	40	30	—
Exhaust manifold studs	8	—	71
A/C compressor bracket-to-cylinder head bolts	48	35	—
A/C compressor bracket-to-cylinder head nut	48	35	—

A/C compressor bracket-to-cylinder head stud bolt	25	18	—
Oil level indicator tube-to-cylinder head bolt	10	—	89
Coolant recovery reservoir bracket-to-GOP bolts	9	—	80
Motor mount-to-subframe nuts	115	85	—
Oil pan drain plug	26	19	—
Wire harness bracket to motor mount nut	27	20	—
Steering column pinch bolt	47	35	—
Front subframe-to-body bolts	90	66	—
Front subframe-to-shock tower bolts	115	85	—
Oil pan-to-cylinder block bolts [a]	—	—	—
Oil pan-to-transmission bell housing	45	33	—
Main bearing bridge nuts	32	24	
Oil pump cover-to-engine front cover bolts	25	18	—
Oil pump cover-to-engine front cover bolt	10	89	—
Oil pickup tube-to-cylinder block bolts	25	18	—
Oil pickup tube-to-oil pan baffle nut	48	35	—
Flywheel-to-crankshaft bolts	80	59	—
Wire harness bracket-to-motor mount stud-nut	27	20	—
Engine ground strap-to-motor mount nut	27	20	—
Motor mount-to-motor mount bracket bolts	70	52	—
RH motor mount-to-motor mount bracket nut	70	52	—
Hood ground strap-to-hood hinge bolt	12	9	—
Hood hinge nuts	12	9	—
Generator mounting bracket	25	18	—
Power steering pump bracket nuts	8	—	71
Power steering pump bolts	25	18	—
Valve tappet guide plate bolts	12	9	—
Generator positive cable nut	10	—	89
Power steering pressure tube to pump nut	40	30	—
Accelerator cable bracket-to-intake manifold bolts	10	—	89
42-pin connector bolt	10	—	89
Transmission oil cooler tube bracket-to-motor mount bracket nut	27	20	
Torque converter-to-flywheel nuts	36	27	—
Engine-to-transmission bolts	40	30	—
Engine mount bracket-to-engine bolts	70	52	—
Engine mount bracket-to-engine nuts	70	52	—
Water pump pulley bolts	25	18	—
Oil filter [b]	—	—	—
Upper intake manifold-to-lower intake manifold bolts [a]	—	—	—
Lower intake manifold-to-cylinder head bolts [a]	—	—	—
Rocker arm pivot-to-cylinder head bolts [a]	—	—	—

Cylinder head bolts [a]	—	—	—
Crankshaft main bearing bolts and studs [a]	—	—	—
Connecting rod cap bolts [a]	—	—	—

[a] Refer to the procedure in this section
[b] Advance one-half turn after gasket contacts the sealing surface.

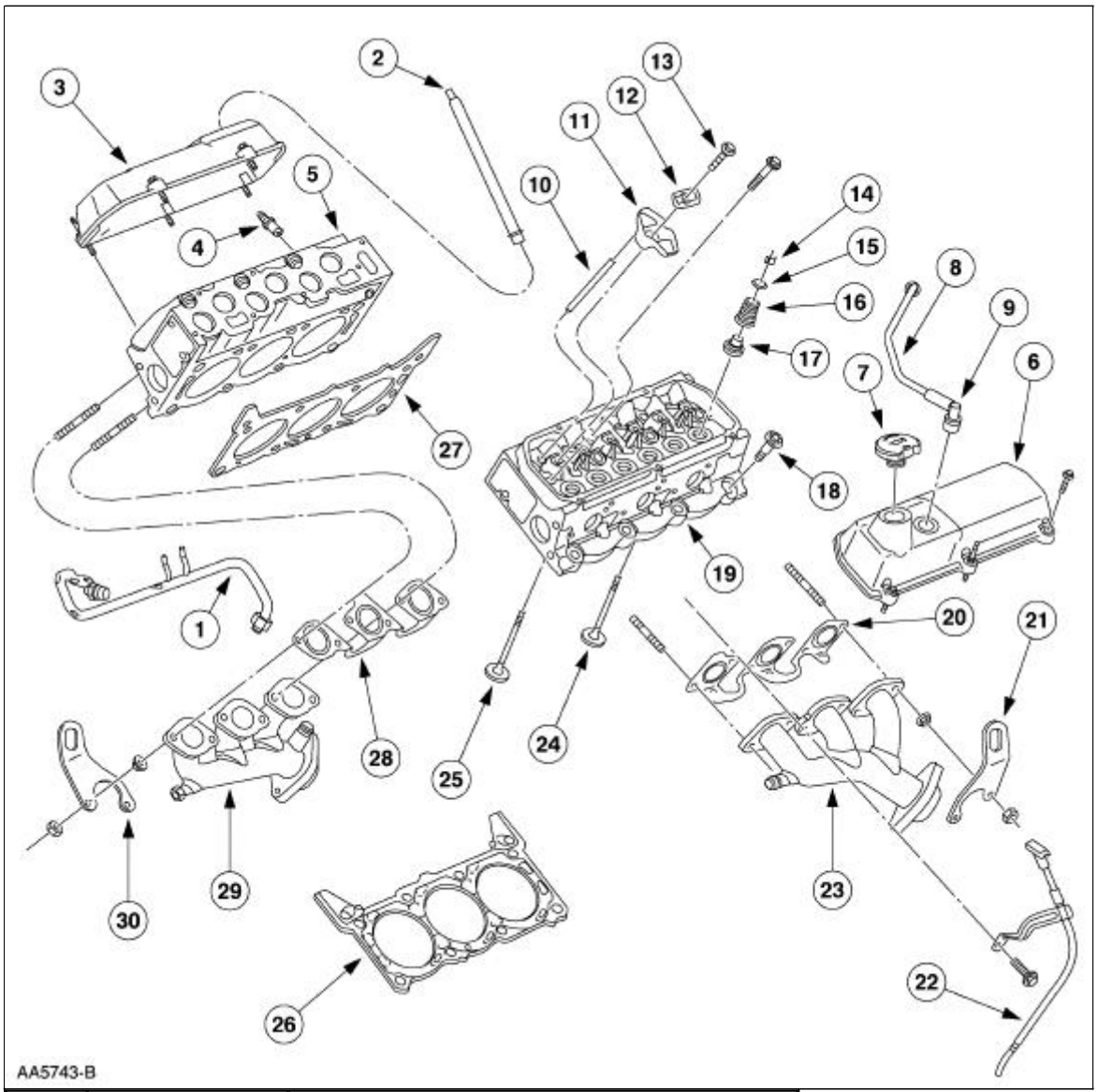
Engine

The 3.8L engine has:

- a V-block with six cylinders and splayed crankpins.
- a distributorless ignition system.
- a multiport, sequential fuel injection (SFI) system.
- overhead valves.
- hydraulic valve tappets for automatic lash adjustment.
- connecting rod parting faces that are unique with an interference fit.
- an engine dynamic balance shaft.

Engine Component View

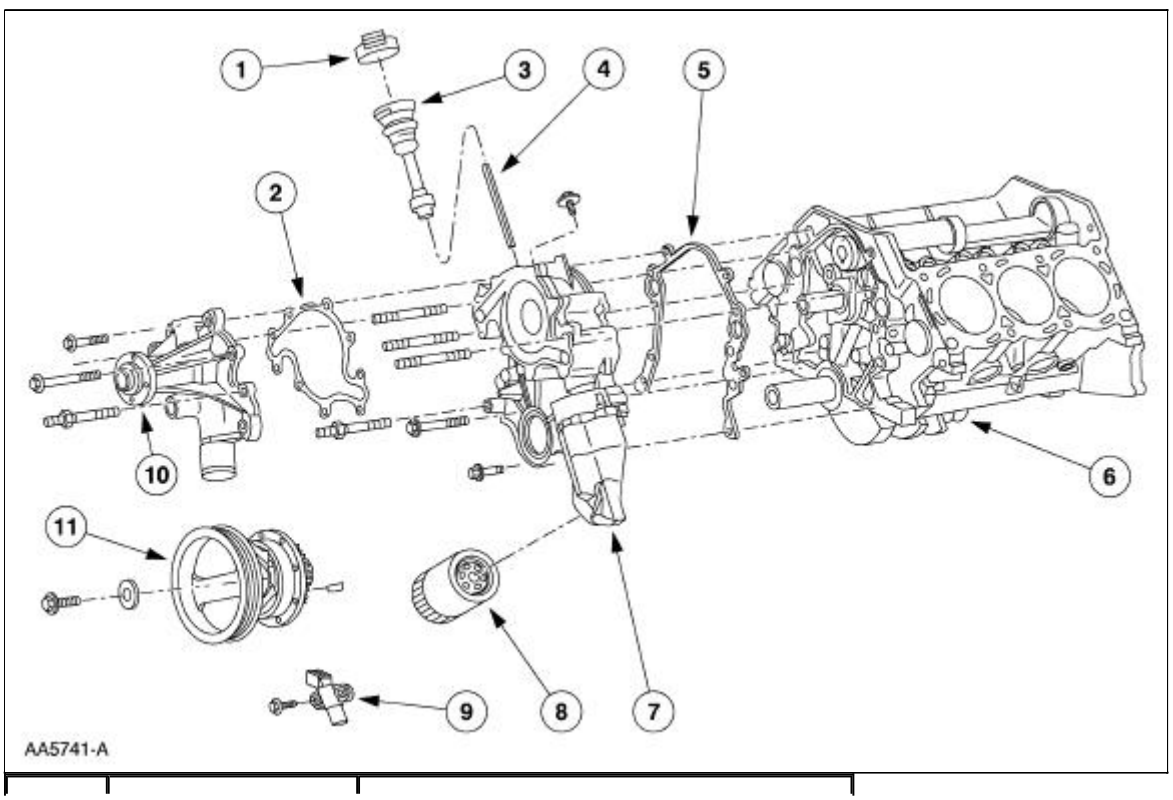
Cylinder Heads and Valve Train Components



Item	Part Number	Description
1	9D477	EGR valve-to-exhaust manifold tube
2	6C342	Crankcase ventilation hose
3	6582	Valve cover — RH
4	12405	Spark plug
5	6049	Cylinder head — RH
6	6582	Valve cover — LH
7	6766	Oil fill cap
8	6758	Crankcase ventilation tube

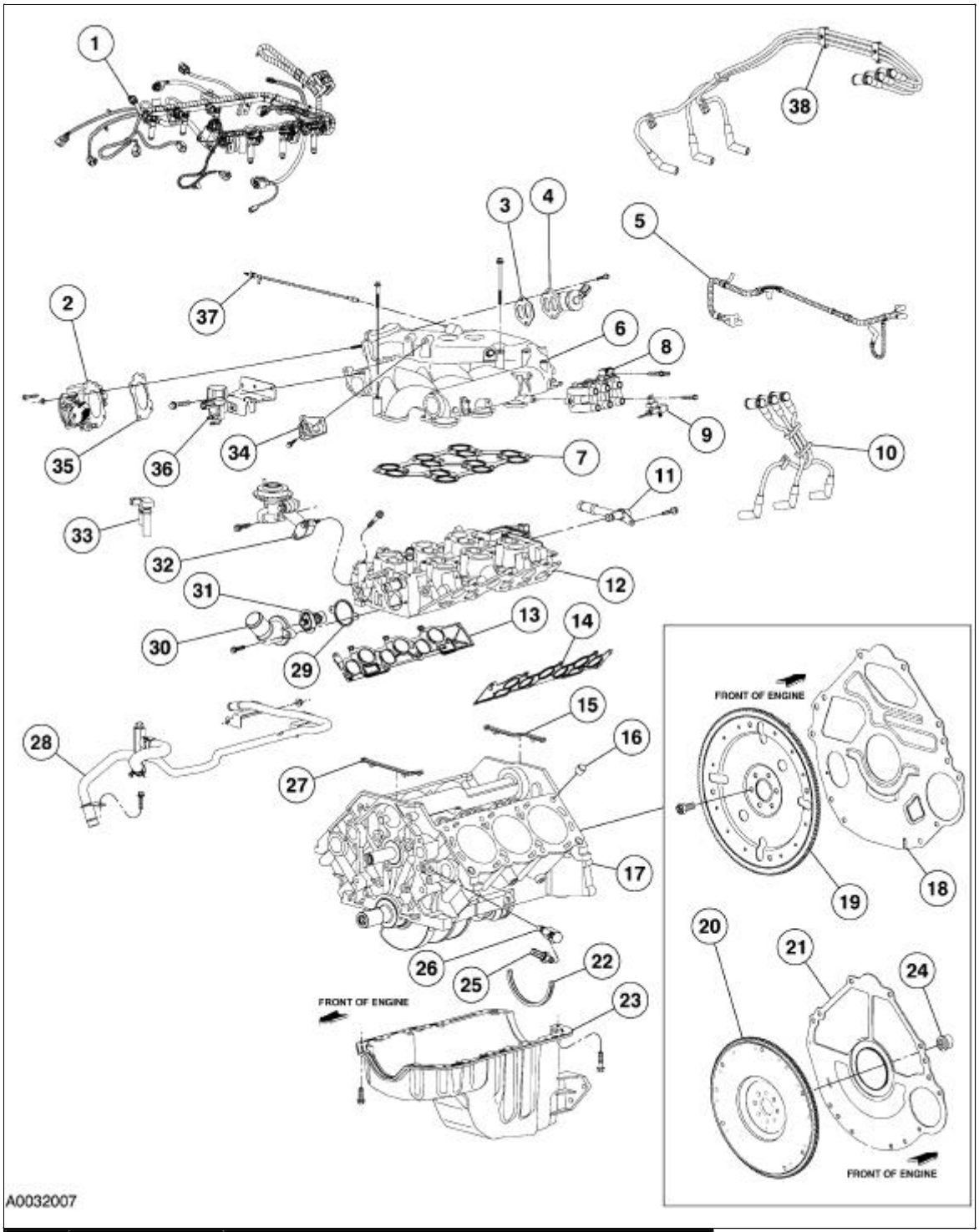
9	6A666	Positive crankcase ventilation valve
10	6565	Push rod
11	6564	Rocker arm
12	6A528	Rocker arm seat
13	N807699	Bolt
14	6518	Valve spring retainer key
15	6514	Valve spring retainer
16	6513	Valve spring
17	6A517	Valve stem seal
18	611497	Bolt
19	6049	Cylinder head — LH
20	9448	Exhaust manifold gasket — LH
21	17A084	Engine lifting eye
22	6754	Oil level indicator tube
23	9430	Exhaust manifold — LH
24	6507	Intake valve
25	6505	Exhaust valve
26	6051	Head gasket — LH
27	6051	Head gasket — RH
28	9448	Exhaust manifold gasket — RH
29	9430	Exhaust manifold — RH
30	17A084	Engine lifting eye

Engine Front Cover Components



Item	Part Number	Description
1	6B288	Camshaft position sensor
2	8507	Water pump housing gasket
3	12A362	Camshaft synchronizer
4	6A618	Oil pump intermediate shaft
5	6020	Engine front cover gasket
6	6010	Cylinder block
7	6019	Engine front cover
8	6714	Oil bypass filter
9	6C315	Crankshaft position sensor
10	8501	Water pump
11	6312	Crankshaft pulley

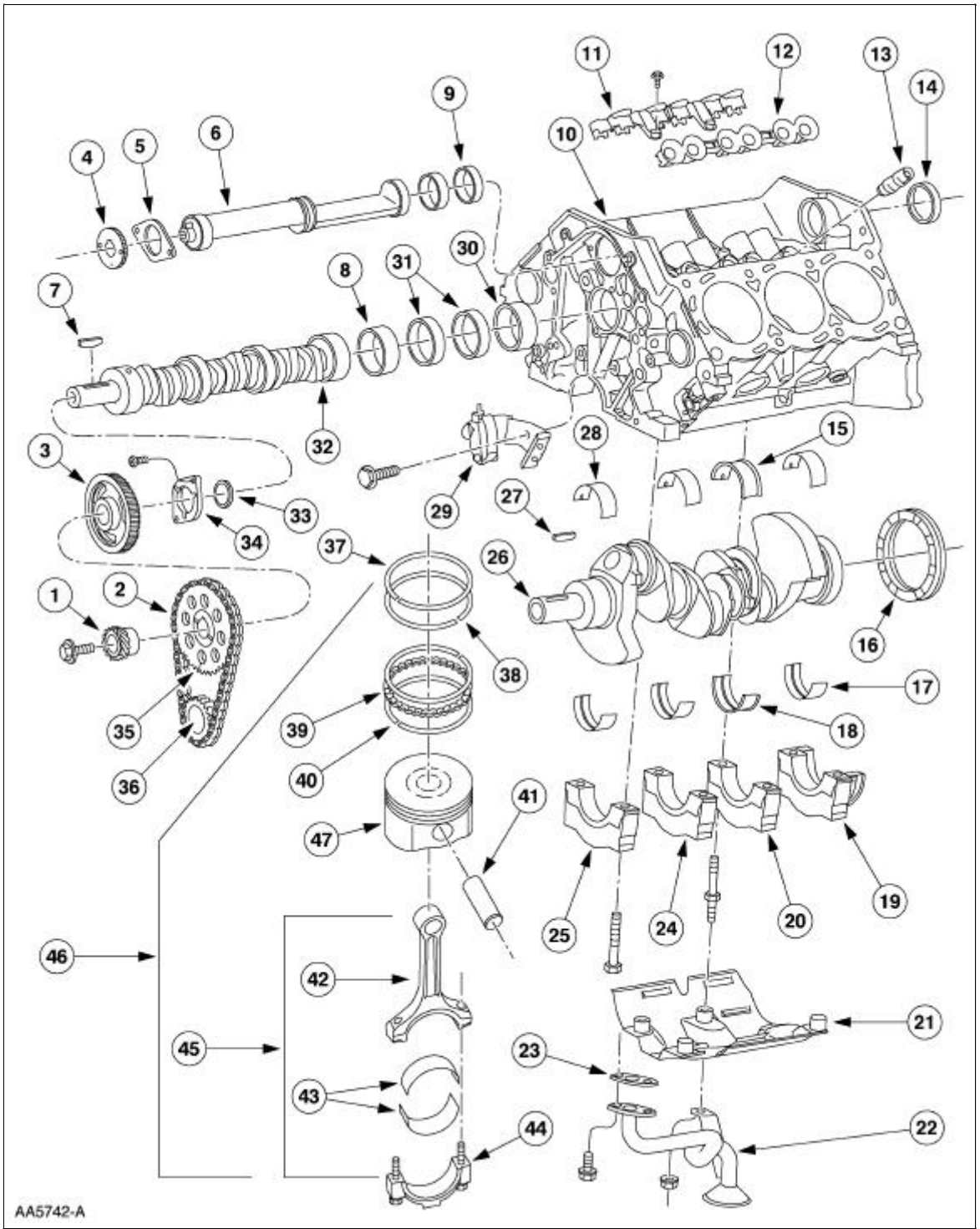
Engine Components



Item	Part Number	Description
1	9F797	Engine wire harness
2	9E926	Throttle body
3	9F670	Idle air control gasket
4	9F715	Idle air control valve
5	9E498	Emissions vacuum harness
6	9424	Intake manifold (upper)
7	9H486	Intake manifold gasket (upper)
8	12029	Ignition coil

9	18801	Radio ignition interference capacitor
10	12281	Ignition wire set — LH
11	18696	Tube assembly
12	9424	Intake manifold (lower)
13	9439	Intake manifold gasket — RH
14	9439	Intake manifold gasket — LH
15	9A424	Intake manifold seal (rear)
16	6A008	Cylinder head-to-block dowel
17	6010	Cylinder block
18	6A373	Engine rear plate (automatic transmission)
19	6375	Flywheel (automatic transmission)
20	6375	Flywheel (manual transmission)
21	6A372	Engine rear plate (manual transmission)
22	6723	Oil pan rear seal
23	6675	Oil pan
24	7120	Pilot bushing
25	9278	Oil pressure sensor
26	9B339	Oil pressure sensor fitting
27	9A424	Intake manifold seal (front)
28	18663	Heater water outlet tube
29	8255	Thermostat housing-to-intake manifold gasket
30	8592	Water outlet connection
31	9875	Water thermostat
32	9D475	EGR valve
33	9H465	Vacuum control solenoid
34	9723	Accelerator cable bracket
35	9E936	Throttle body gasket
36	9J433	EGR transducer
37	9E498	Vacuum hose
38	12280	Ignition wire set — RH

Cylinder Block and Lower End Components



Item	Part Number	Description
1	6255	Distributor drive gear
2	6268	Timing chain
3	6A303	Engine balance shaft drive gear
4	6A304	Engine balance shaft driven gear
5	6C341	Balance shaft thrust plate
6	6A311	Engine dynamic balance shaft
7	W705934	Woodruff key
8	6261	Camshaft bearing

9	6A333	Balance shaft front and rear bearing
10	6010	Cylinder block
11	6K564	Tappet guide plate and retainer — RH
12	6K564	Tappet guide plate and retainer — LH
13	6500	Valve tappet
14	376958	Balance shaft cover plug
15	6337	Crankshaft thrust main bearing
16	6701	Crankshaft rear oil seal
17	6A338	Crankshaft main bearing (lower)
18	6A339	Crankshaft thrust main bearing
19	6325	Rear main bearing cap
20	6327	Main bearing cap
21	6687	Oil pan baffle
22	6622	Oil pump screen cover and tube
23	6625	Oil pump inlet tube gasket
24	6334	Main bearing cap
25	6329	Main bearing cap
26	6303	Crankshaft
27	388907	Woodruff key
28	6333	Crankshaft main bearing (upper)
29	6284	Timing chain vibration damper
30	6263	Camshaft rear bearing
31	6262	Camshaft center bearing
32	6250	Camshaft
33	6265	Camshaft sprocket spacer
34	6269	Camshaft thrust plate
35	6256	Camshaft sprocket
36	6303	Crankshaft sprocket
37	6150	Piston ring
38	6152	Piston ring
39	6161	Piston ring
40	6159	Piston ring
41	6135	Piston pin
42	6200	Connecting rod
43	6211	Connecting rod bearing
44	6210	Connecting rod cap
45	6200	Connecting rod assembly
46	6100	Piston and connecting rod assembly
47	6108	Piston

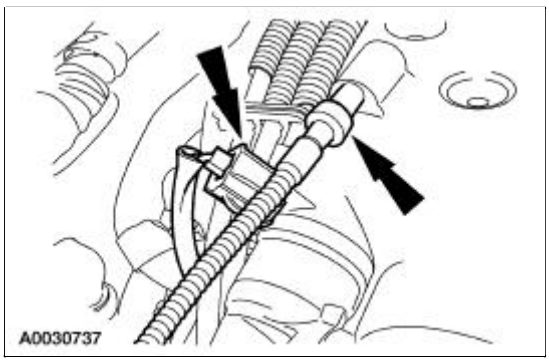
Engine

Refer to Section 303-00 for basic mechanical concerns or refer to the Powertrain Control/Emissions Diagnosis (PC/ED) manual for driveability concerns.

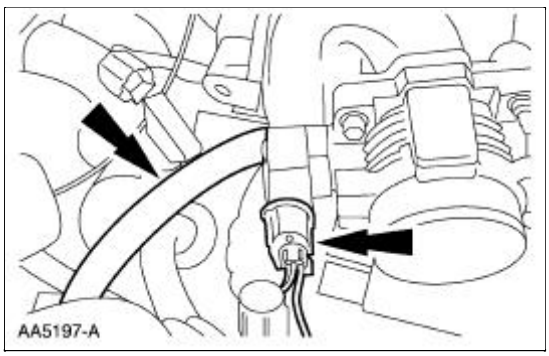
Upper Intake Manifold

Removal

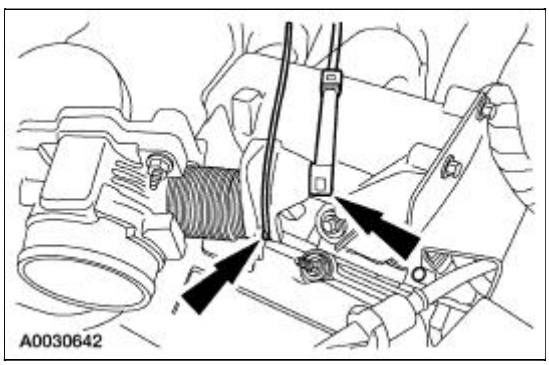
1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .
2. Remove the engine air cleaner outlet pipe. For additional information, refer to Section 303-12 .
3. Disconnect the vacuum hose and the idle air control (IAC) valve electrical connector.



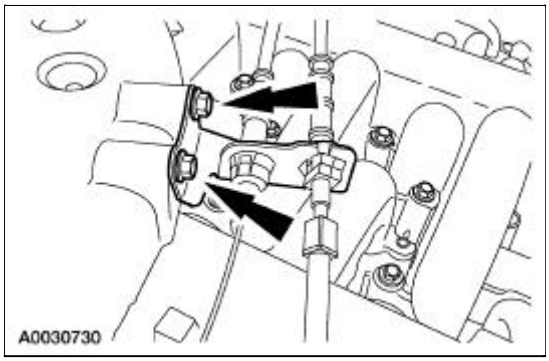
4. Disconnect the throttle position (TP) sensor electrical connector and the evaporative emissions (EVAP) return tube.



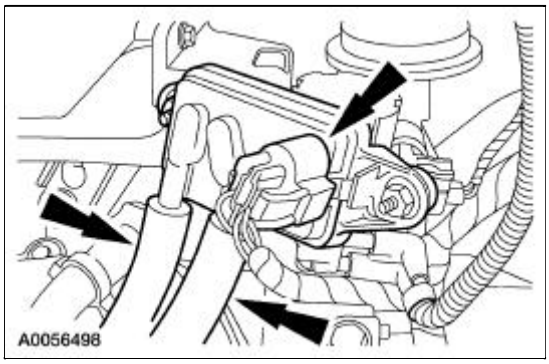
5. Disconnect the accelerator and the speed control cables from the throttle body cam.



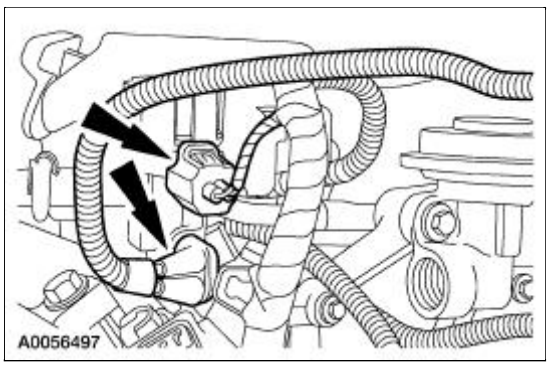
6. Remove the bolts and position the accelerator cable bracket assembly aside.



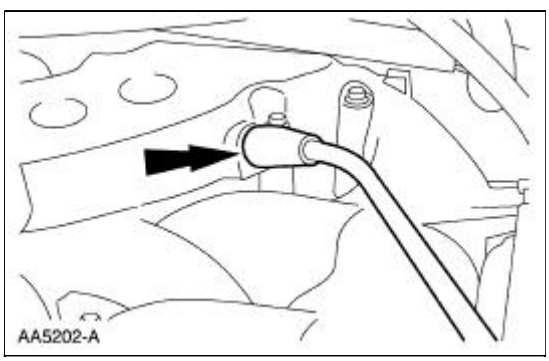
7. Disconnect the differential pressure feedback exhaust gas recirculation (EGR) system electrical and vacuum connections.



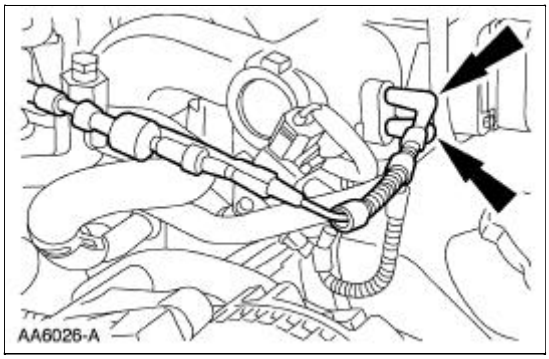
8. Disconnect the EGR vacuum regulator solenoid electrical and vacuum connections.



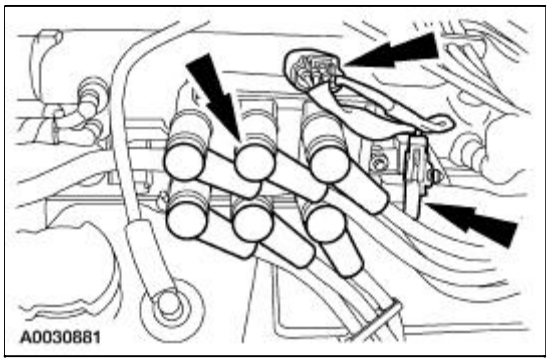
9. Disconnect the positive crankcase ventilation (PCV) tube.



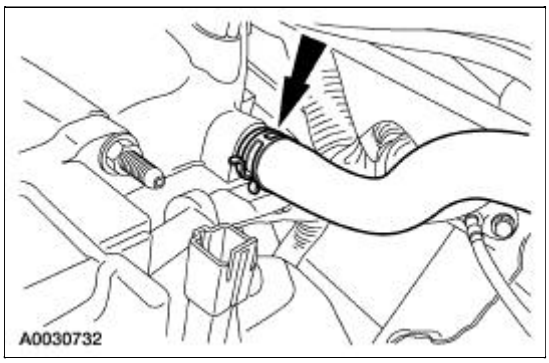
10. Disconnect the vacuum hoses.



11. Disconnect the following:
    - Ignition coil electrical connector.
    - Radio interference capacitor electrical connector.
    - Spark plug wires.

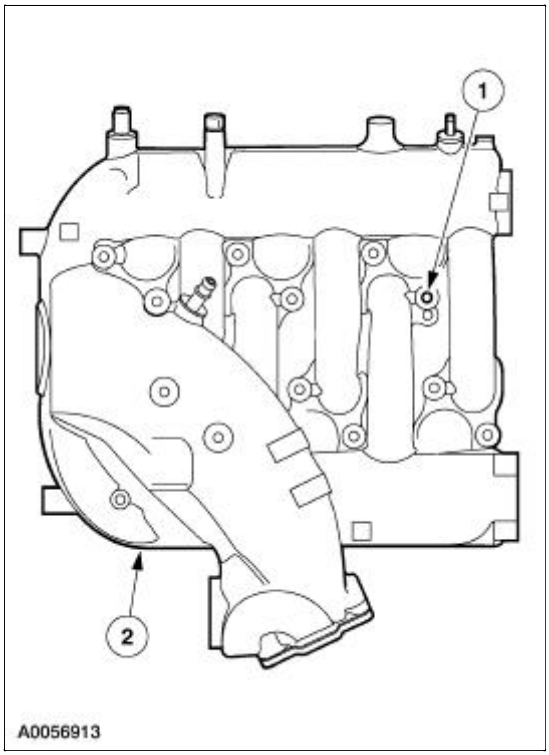


12. Disconnect the vacuum hose.

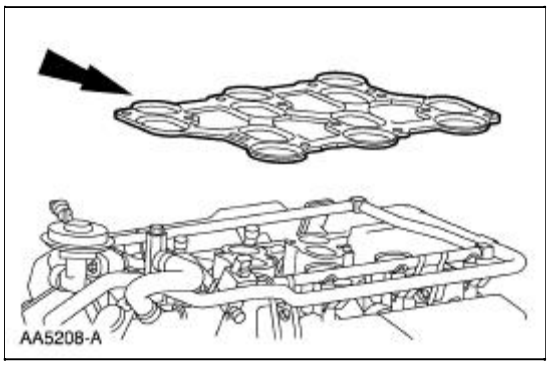


13. **NOTE:** For ease in installation, record the location of the long bolts and the short bolts.

    Remove the upper intake manifold.
    1. Remove the 12 bolts.
    2. Remove the upper intake manifold.

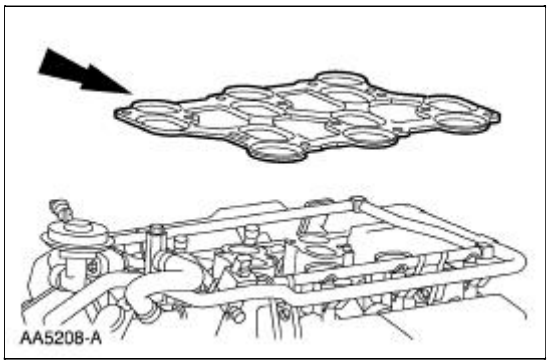


14. Remove and discard the upper intake manifold gasket.



Installation

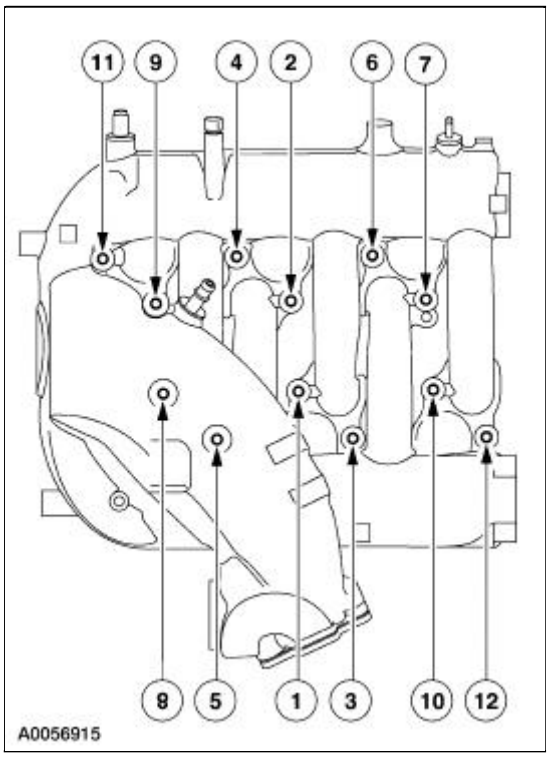
1. Install a new upper intake manifold gasket.



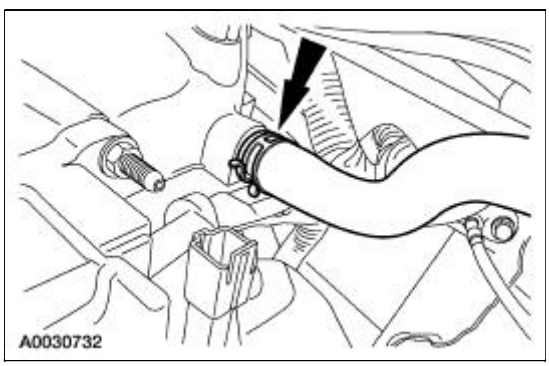
2. **NOTE:** Refer to the location note made during removal and make sure the bolts are installed in the correct locations.

   Install the upper intake manifold. Tighten the bolts in two stages in the sequence shown.

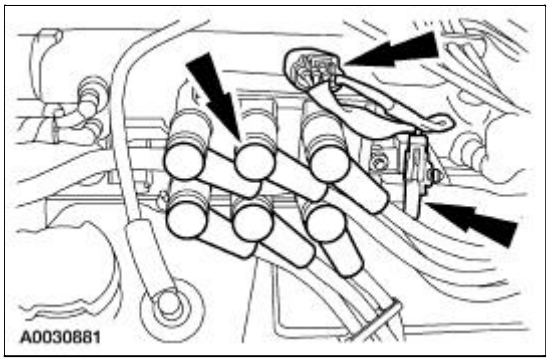
- Stage 1: Tighten to 10 Nm (89 lb-in).
- Stage 2: Rotate an additional 90 degrees (1/4 turn).



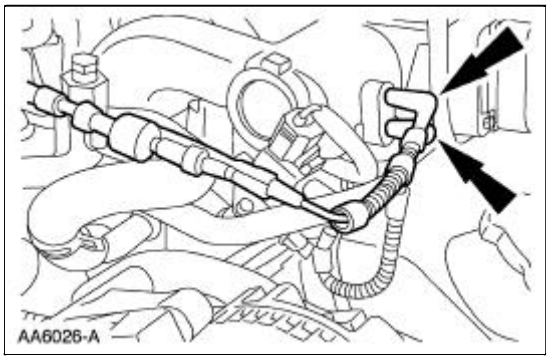
3. Connect the vacuum hose.



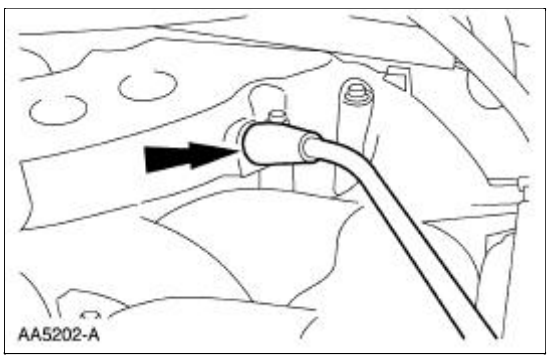
4. Connect the following:
   - Ignition coil electrical connector.
   - Radio interference capacitor electrical connector.
   - Spark plug wires.



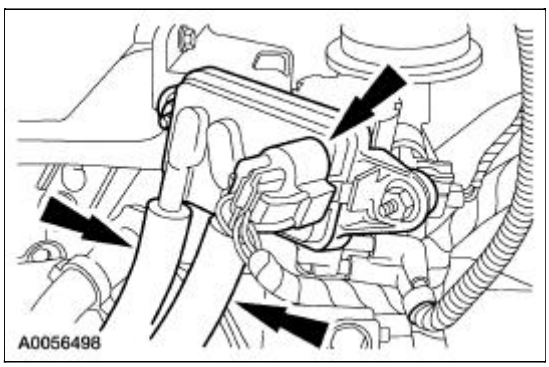
5. Connect the vacuum hoses.



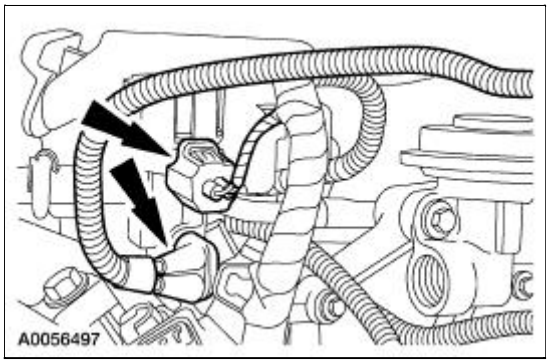
6. Connect the PCV tube.



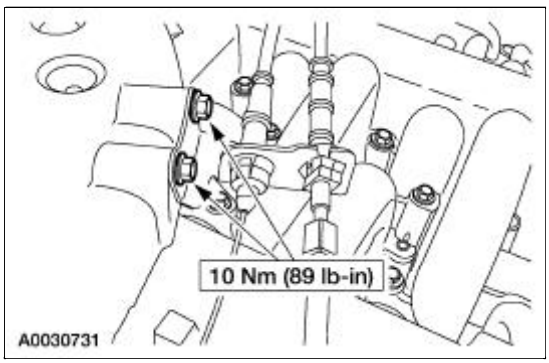
7. Connect the differential pressure feedback EGR system electrical and vacuum connections.



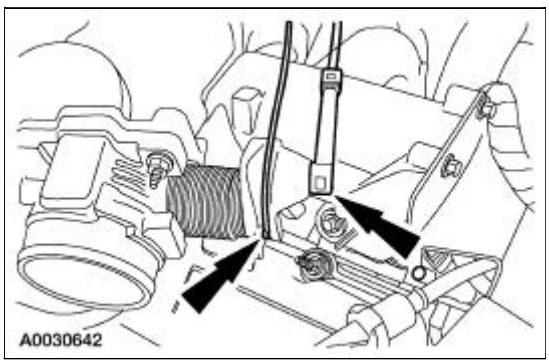
8. Connect the EGR vacuum regulator solenoid electrical and vacuum connections.



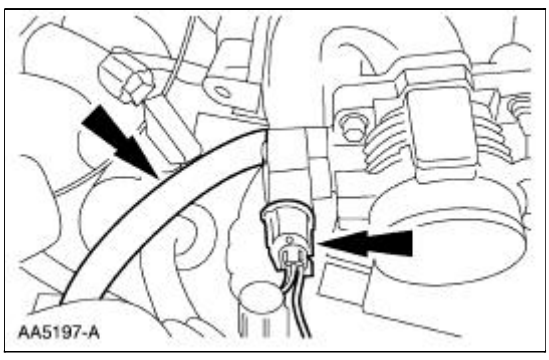
9. Position the accelerator cable bracket and install the bolts.



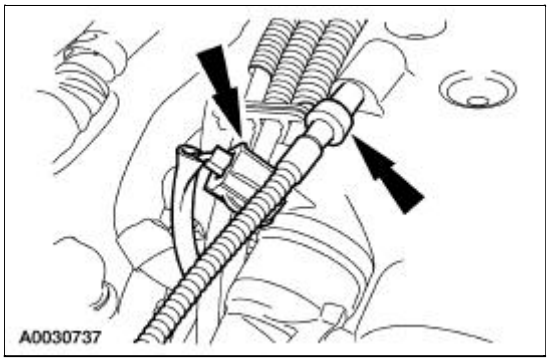
10. Connect the accelerator and speed control cables to the throttle body cam.



11. Connect the EVAP return tube and the TP sensor electrical connector.



12. Connect the vacuum hose and the IAC valve electrical connector.



13. Install the engine air cleaner outlet pipe. For additional information, refer to Section 303-12 .
14. Connect the battery ground cable. For additional information, refer to Section 414-01 .

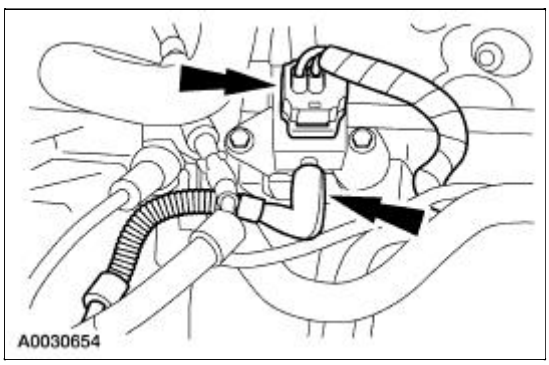
Lower Intake Manifold

Material

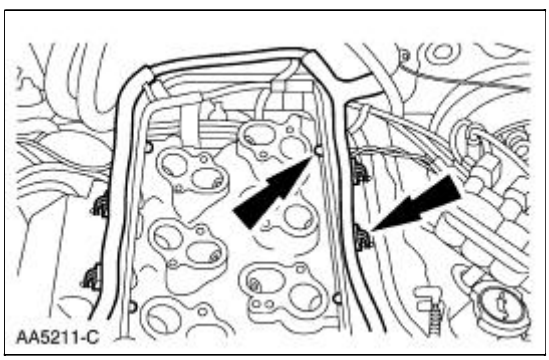
Item	Specification
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4
Metal Surface Cleaner F4AZ-19A536-RA or equivalent	WSE-M5B392-A

Removal

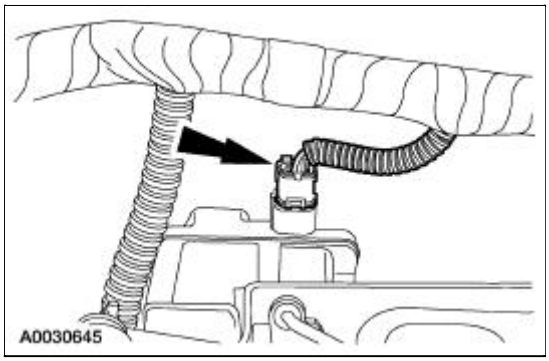
1. Remove the upper intake manifold. For additional information, refer to Upper Intake Manifold in this section.
2. Partially drain the cooling system. For additional information, refer to Section 303-03A .
3. Relieve the fuel system pressure. For additional information, refer to Section 310-00 .
4. Disconnect the fuel rail pressure (FRP) sensor electrical connector and vacuum hose.



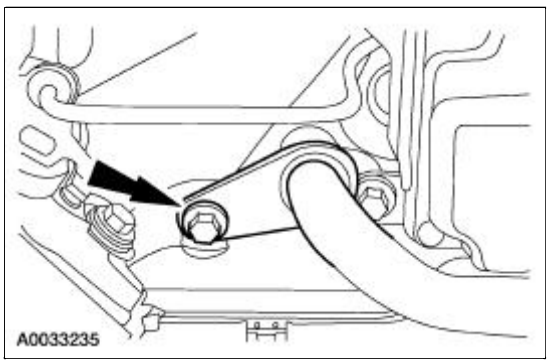
5. Disconnect the fuel supply tube spring lock coupling. For additional information, refer to Section 310-00 .
6. Disconnect and position the engine wire harness aside.



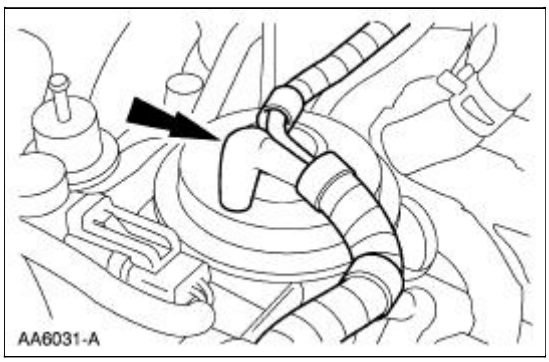
7. Disconnect the intake manifold runner control (IMRC) electrical connector.



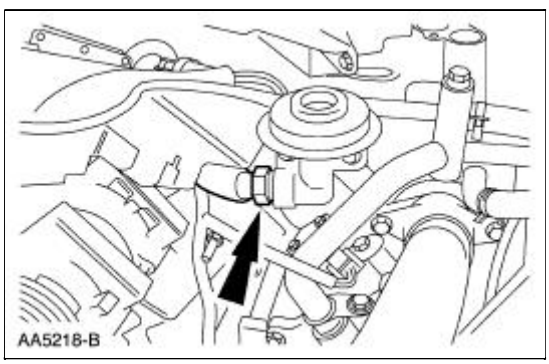
8. Remove the heater bypass tube. For additional information, refer to Section 303-03A .
9. Disconnect the heater hose.



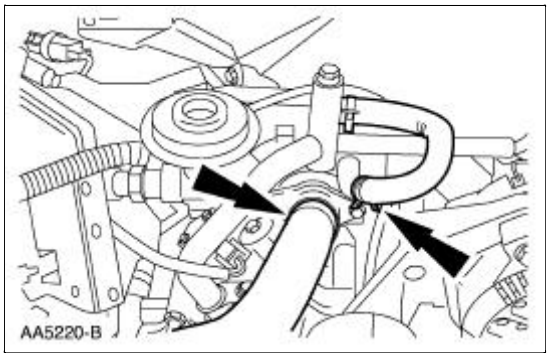
10. Disconnect the exhaust gas recirculation (EGR) vacuum tube.



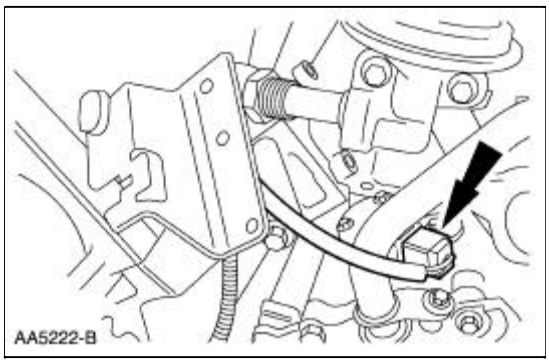
11. Disconnect the EGR tube from the EGR valve.



12. Disconnect the radiator upper hose and coolant bypass hose.

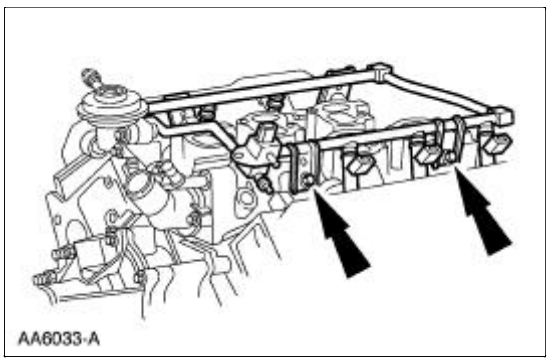


13. Disconnect the electrical connector.



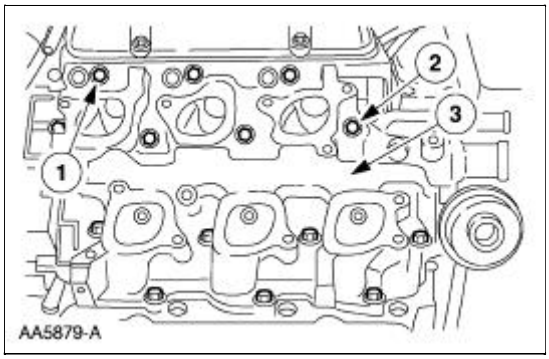
14. **NOTE:** Remove the fuel injection supply manifold and fuel injectors as an assembly.

    Remove the bolts and the fuel injection supply manifold.

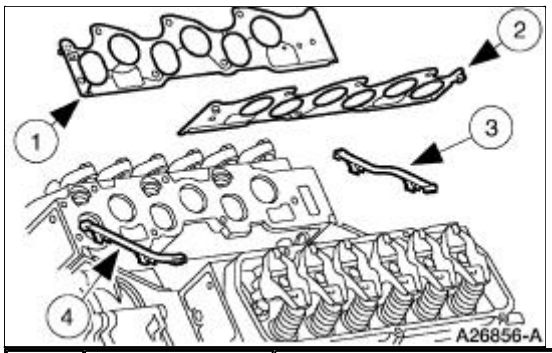


15. **NOTE:** For ease in installation, record the location of the short bolts and the long bolts.

    Remove the lower intake manifold.
    1. Remove the eight short bolts.
    2. Remove the six long bolts.
    3. Remove the lower intake manifold.



16. Remove and discard the intake manifold gaskets.

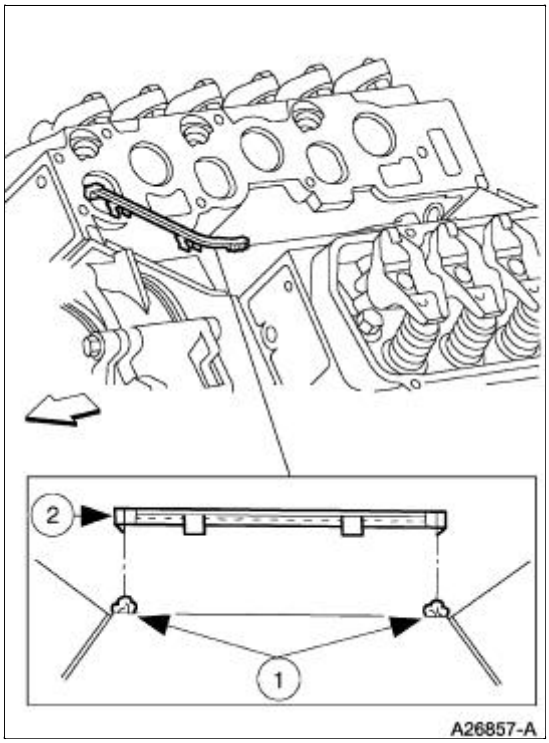


Item	Part Number	Description
1	9439	Intake manifold gasket—RH
2	9441	Intake manifold gasket—LH
3	9A424	Intake manifold rear end seal (part of 9439)
4	9A425	Intake manifold front end seal (part of 9439)

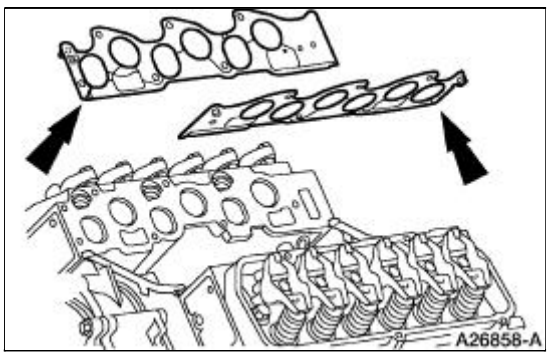
Installation

1. **NOTE:** If the lower intake manifold is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.

   Install the lower intake manifold front and rear end seals.
   1. Apply a bead of silicone gasket and sealant to the intake manifold front and rear end seal mounting points as indicated.
   2. Install the lower intake manifold front and rear end seals.

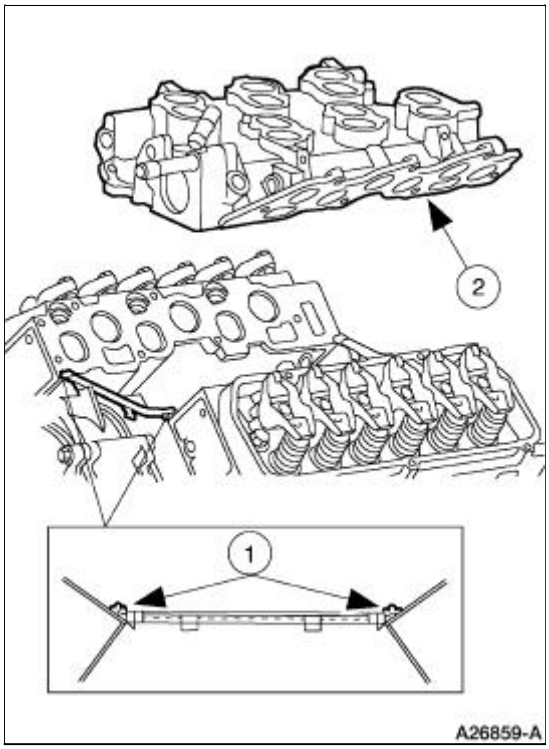


2. Install the intake manifold gaskets.



3. **NOTE:** If the lower intake manifold is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.

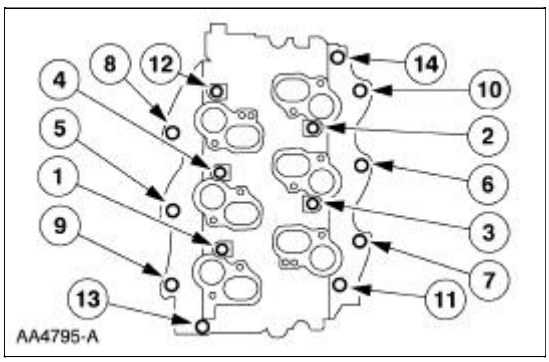
   Position the lower intake manifold.
   1. Apply a bead of silicone gasket and sealant to the lower intake manifold mounting at the points indicated.
   2. Position the lower intake manifold.



4. **NOTE:** Refer to the location note made during removal and make sure the bolts are installed in the correct location.

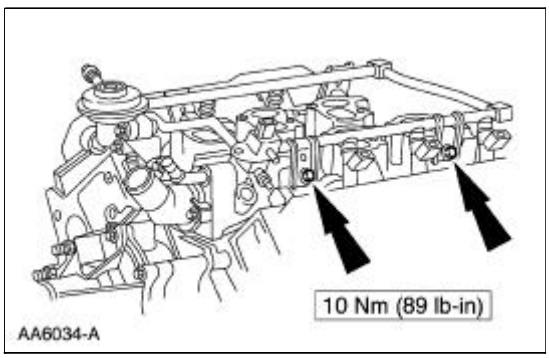
   Tighten the bolts in two stages in the sequence shown:

   - Stage 1: Tighten the bolts to 5 Nm (44 lb-in).
   - Stage 2: Tighten the bolts to 10 Nm (89 lb-in).

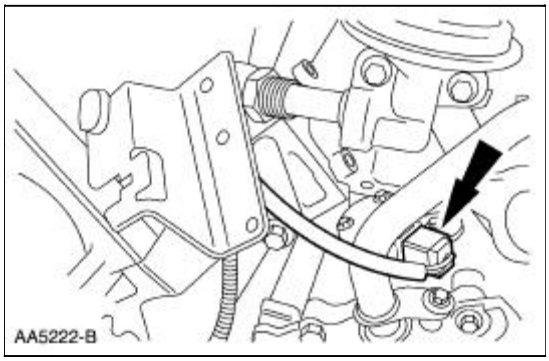


5. **NOTE:** Install the fuel injection supply manifold and fuel injectors as an assembly.

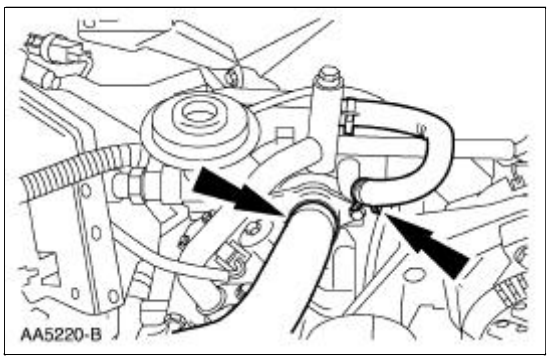
   Install the fuel injector supply manifold and bolts.



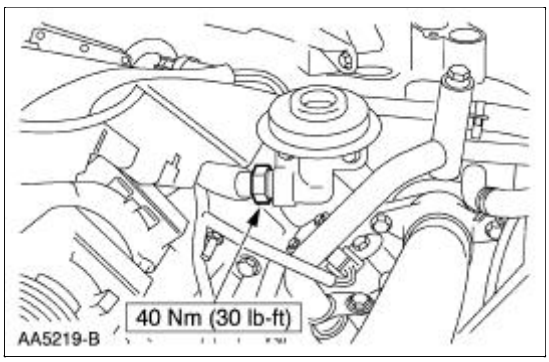
6. Connect the electrical connector.



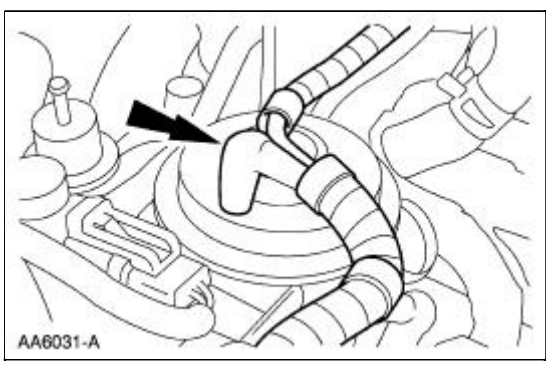
7. Connect the coolant hoses.



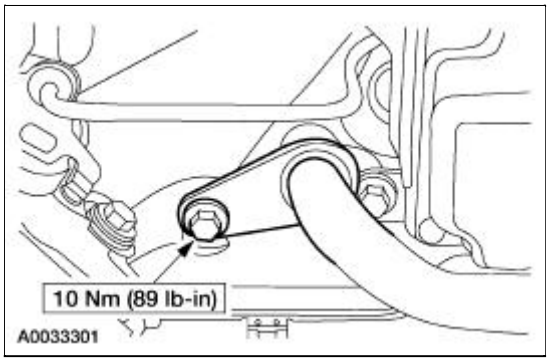
8. Connect the EGR tube.



9. Connect the EGR vacuum tube.

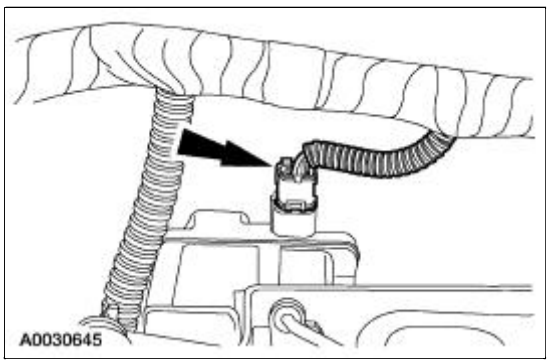


10. Lubricate the O-ring with water and install the heater hose.

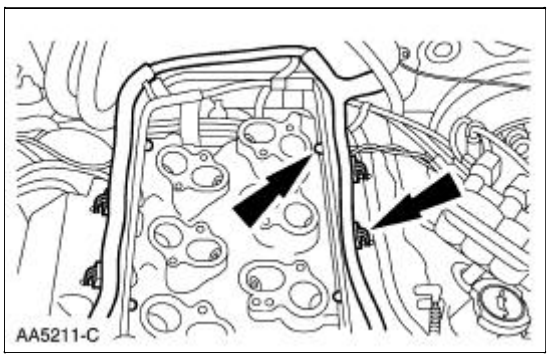


11. Install the heater bypass tube. For additional information, refer to Section 303-03A .

12. Connect the IMRC electrical connector.

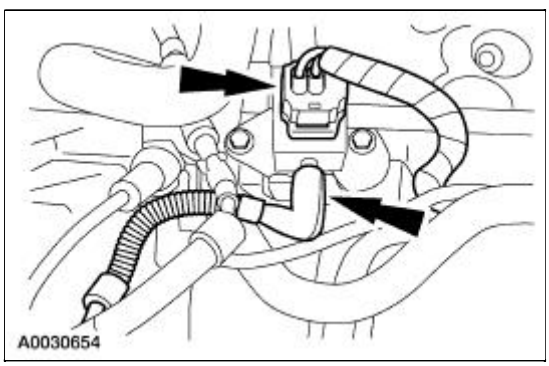


13. Position and connect the engine wire harness. Install the pin-type retainers.



14. Connect the fuel supply tube spring lock coupling. For additional information, refer to Section 310-00 .

15. Connect the FRP sensor electrical connector and the vacuum hose.



16. Install the upper intake manifold. For additional information, refer to Upper Intake Manifold in this section.

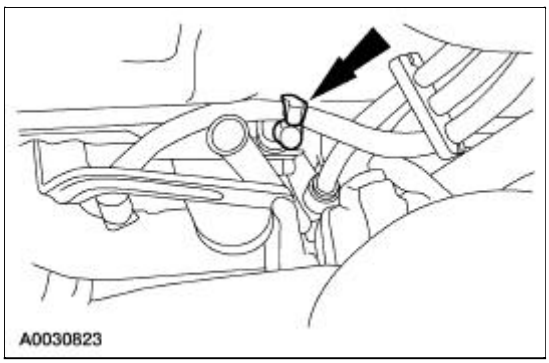
17. **CAUTION: Correct cooling system bleeding is critical for correct engine cooling.**

    Fill and bleed the cooling system. For additional information, refer to Section 303-03A .

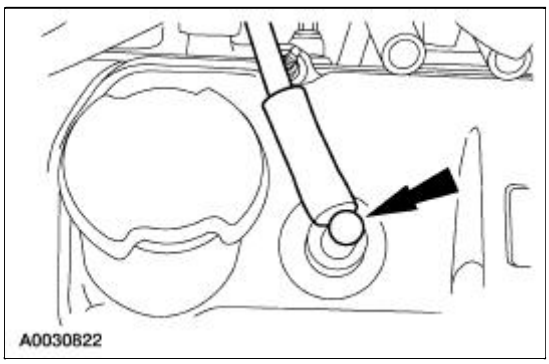
Valve Cover —LH

Removal and Installation

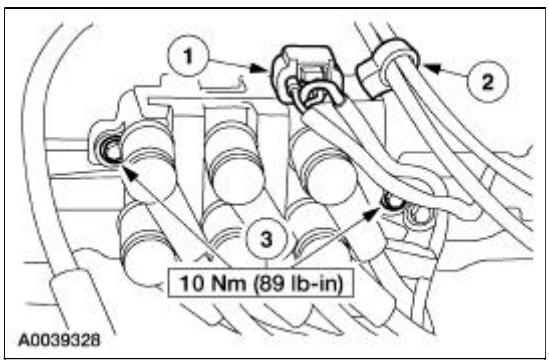
1. Position the ignition wires (12281) aside.



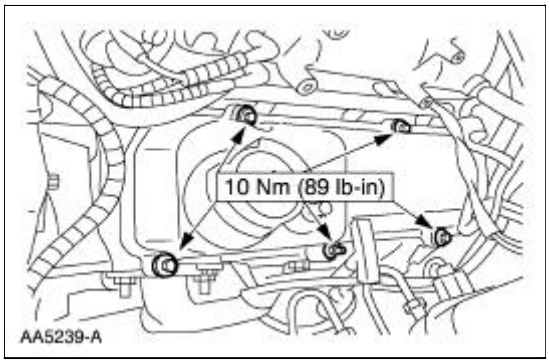
2. Disconnect the positive crankcase ventilation (PCV) valve (6758).



3. Remove the ignition coil and position aside.
    1. Disconnect the electrical connector.
    2. Disconnect the accelerator control cable retainer.
    3. Remove the bolts.



4. Remove the LH valve cover (6A565).
    - Inspect the gasket (6584) and install a new gasket if necessary.

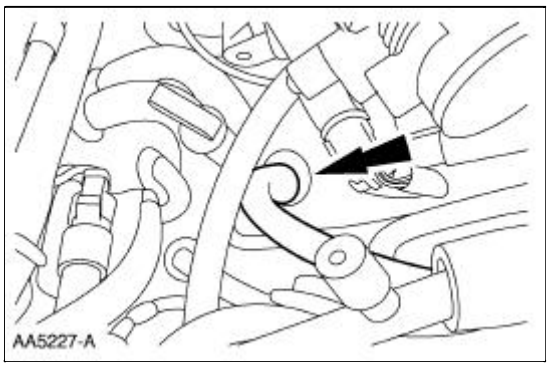


5. To install, reverse the removal procedure.

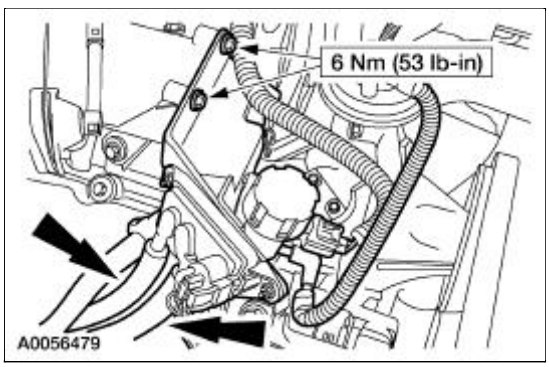
Valve Cover RH

Removal and Installation

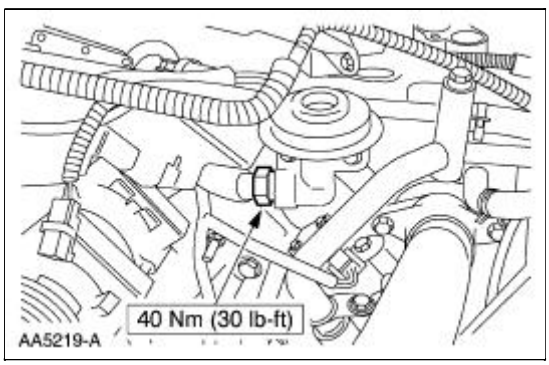
1. Remove the throttle body. For additional information, refer to Section 303-04A .
2. Disconnect the crankcase vent hose.



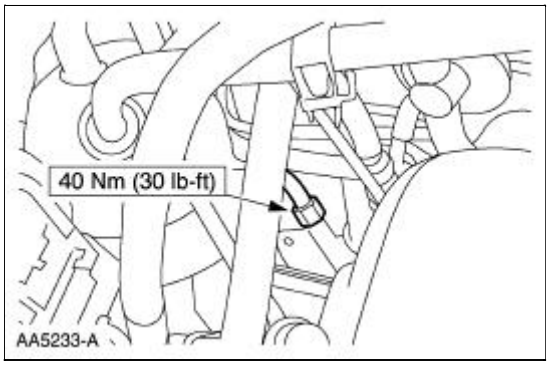
3. Remove the differential feedback exhaust gas recirculation (EGR) system vacuum hoses and the bracket bolts. Position the bracket assembly aside.



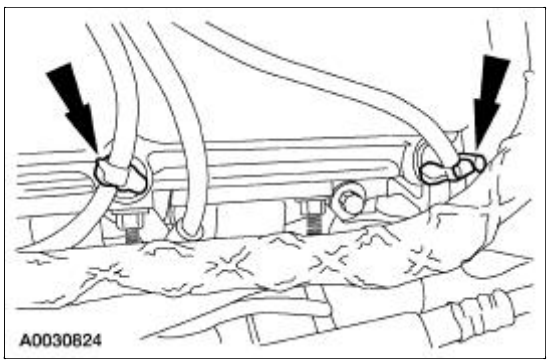
4. Disconnect the EGR tube.



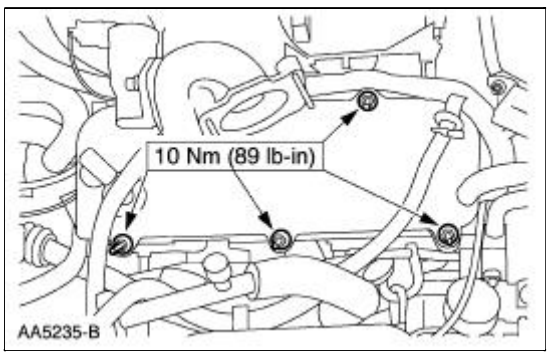
5. Remove the EGR tube.



6. Position the spark plug wires aside.



7. Remove the RH valve cover.



8. To install, reverse the removal procedure.
    - Install a new valve cover gasket as necessary.

Crankshaft Pulley

Special Tool(s)

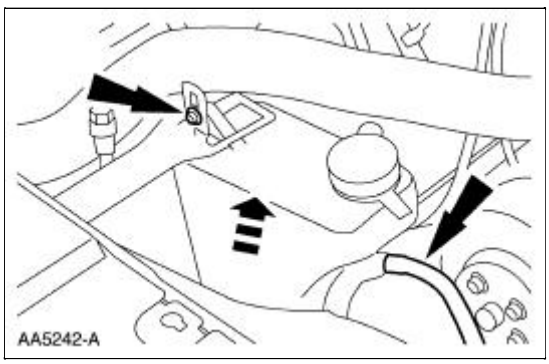
ST1286-A	Remover, Crankshaft Vibration Damper 303-009 (T58P-6316-D)
ST1378-A	Remover, Crankshaft Vibration Damper 303-176 (T82L-6316-B)
ST1387-A	Installer, Crankshaft Damper/Crankshaft Front Oil Seal 303-175 (T82L-6316-A)

Material

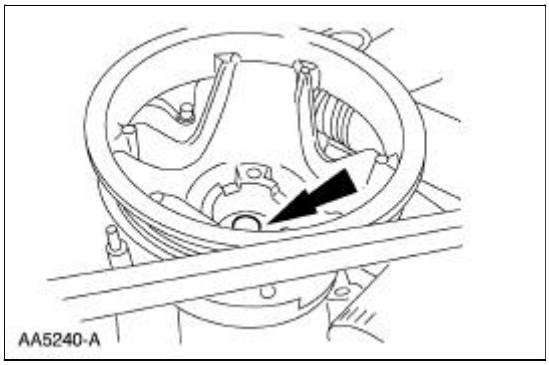
Item	Specification
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4

Removal

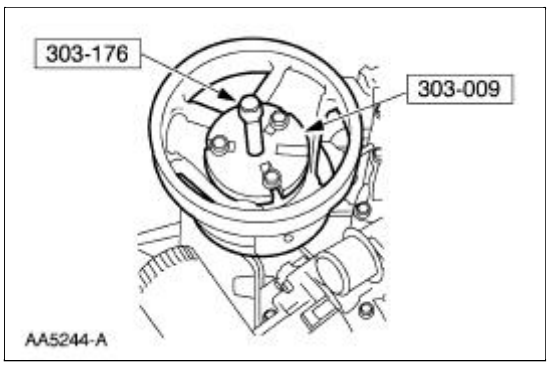
1. Remove the drive belt (8620). For additional information, refer to Section 303-05 .
2. Remove the radiator coolant recovery reservoir (8A080).


AA5242-A

3. Raise the vehicle on a hoist. For additional information, refer to Section 100-02 .
4. Remove the crankshaft pulley bolt.

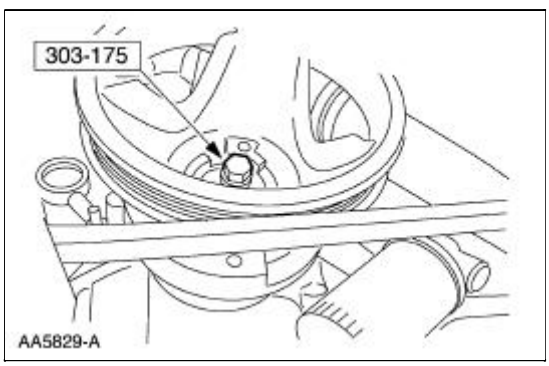


5. Using the special tool, remove the crankshaft pulley (6B321).

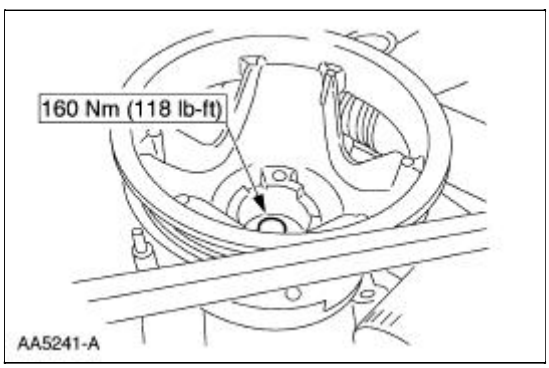


Installation

1. Apply a bead of silicone gasket and sealant to the keyway in the crankshaft damper and use the special tool to install the crankshaft pulley.

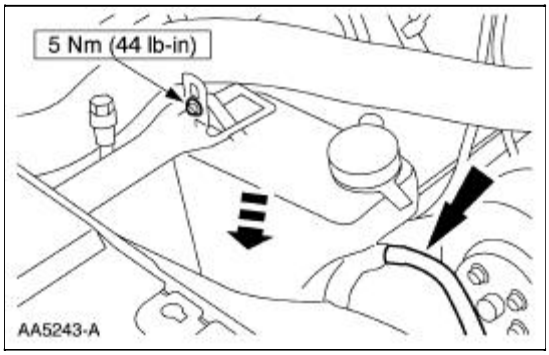


2. Install the crankshaft bolt.



3. Lower the vehicle.

4. Install the radiator coolant recovery reservoir.



5. Install the drive belt. For additional information, refer to Section 303-05 .

Crankshaft Front Seal

Special Tool(s)

ST1328-A	Installer, Front Cover Oil Seal 303-335 (T88T-6701-A)
ST1379-A	Installer, Crankshaft Front Oil Seal 303-474 (T94P-6701-AH)
ST1385-A	Remover, Oil Seal 303-409 (T92C-6700-CH)

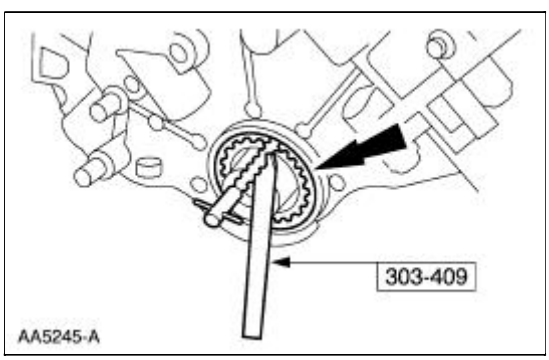
Material

Item	Specification
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Removal

1. Remove the crankshaft pulley. For additional information, refer to Crankshaft Pulley in this section.

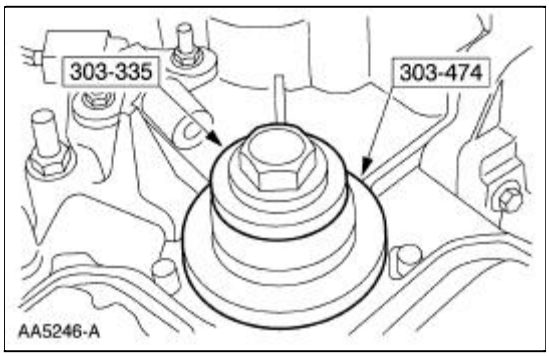
2. Using the special tool, remove and discard the crankshaft front seal.



Installation

1. **NOTE:** Lubricate the crankshaft front seal with clean engine oil before assembly.

   Using the special tool, install the crankshaft front seal.



2. Install the crankshaft pulley. For additional information, refer to Crankshaft Pulley in this section.

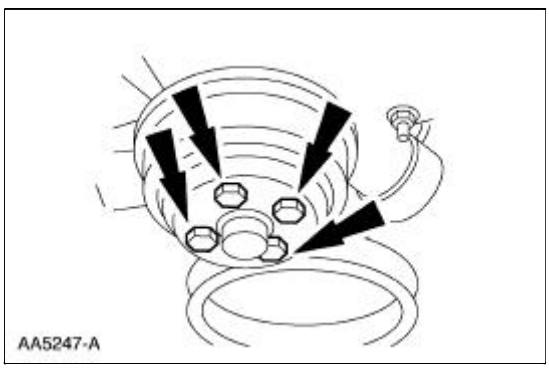
Engine Front Cover

Material

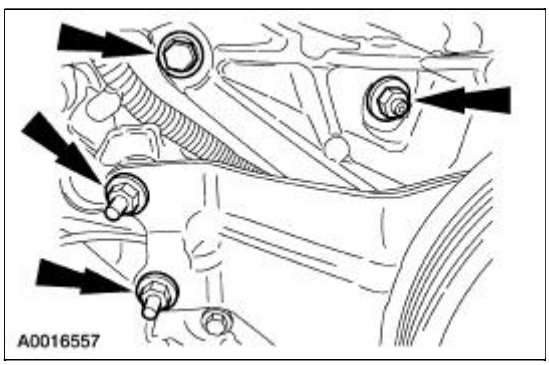
Item	Specification
Metal Surface Cleaner F4AZ-19A536-RA or equivalent	WSE-M5B392-A
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Removal

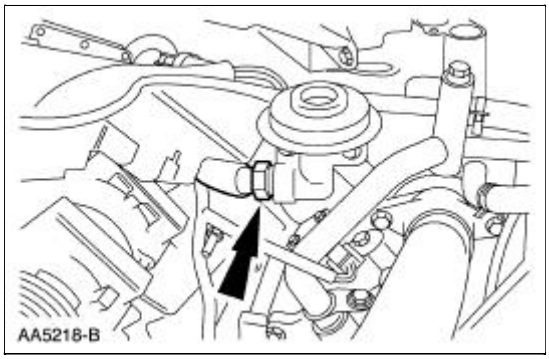
1. Disconnect the battery ground cable. For additional information, refer to Section 414-01 .
2. Drain the engine cooling system. For additional information, refer to Section 303-03A .
3. Remove the crankshaft pulley. For additional information, refer to Crankshaft Pulley in this section.
4. Remove the water pump pulley.



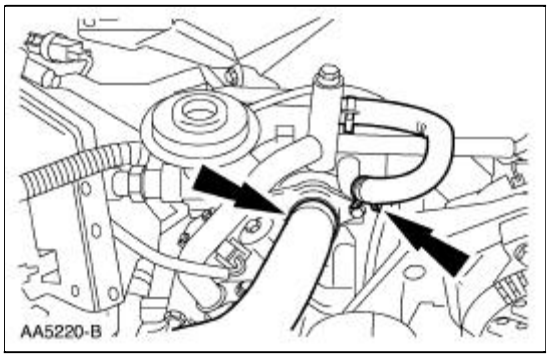
5. Remove the retainers and position the power steering pump aside.



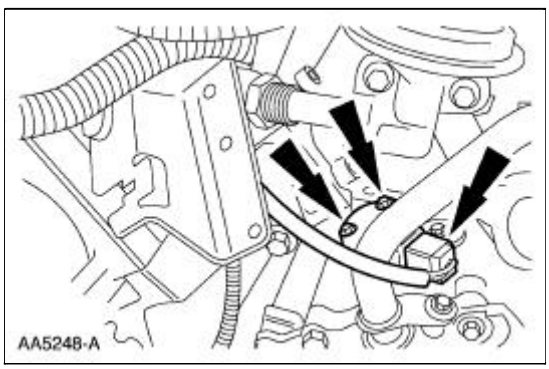
6. Disconnect the exhaust gas recirculation (EGR) tube.



7. Disconnect the upper radiator hose and the bypass hose.

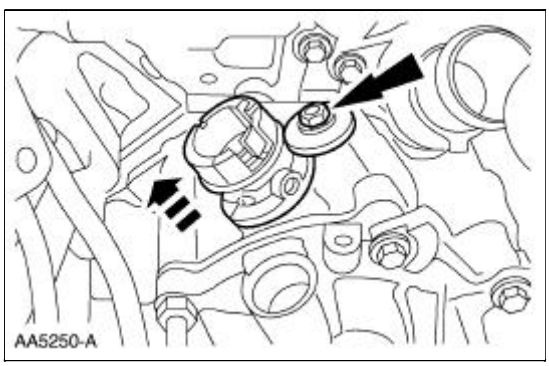


8. Remove the camshaft position (CMP) sensor.

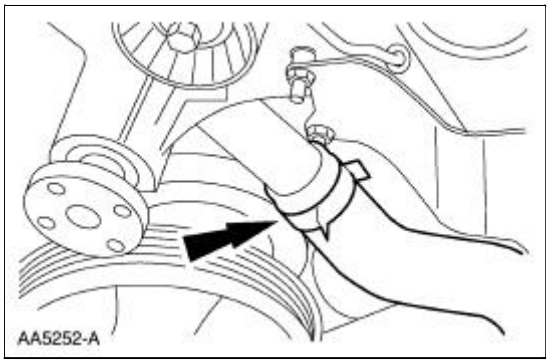


9. Remove the heater water outlet tube. For additional information, refer to Section 303-03A .

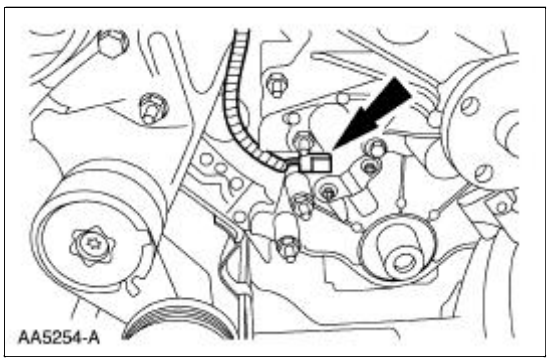
10. Remove the camshaft synchronizer assembly.



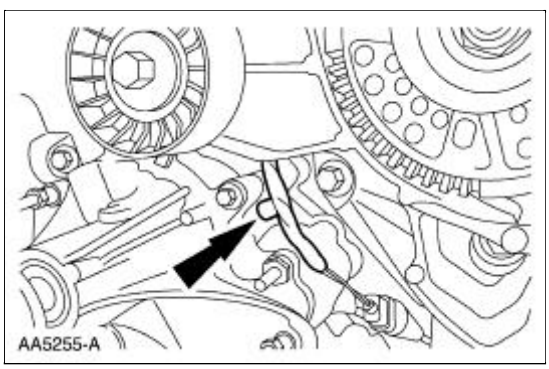
11. Disconnect the lower radiator hose.



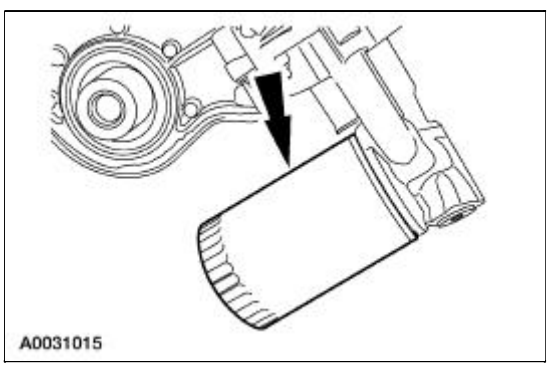
12. Disconnect the crankshaft position sensor electrical connector.



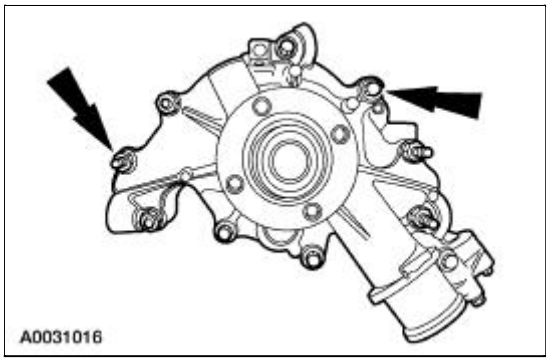
13. Remove the wiring harness pin-type retainer.



14. Remove the oil filter.



15. Remove the retainers and the water pump.

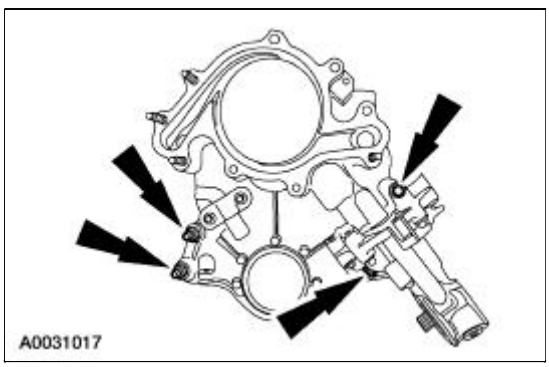


16. **CAUTION: The cap screw is hidden; make sure to remove it or the engine front cover will be damaged.**

    NOTE: Record the location, type and size of the fasteners.

    Remove the engine front cover.

    - Slide the engine front cover off the two dowels.
    - Remove and discard the engine front cover gasket.



Installation

1. **CAUTION: In order to prevent foreign material from contaminating the engine block or the engine front cover it is necessary to seal the coolant and oil passages of both components. Failure to follow these directions will result in engine damage.**

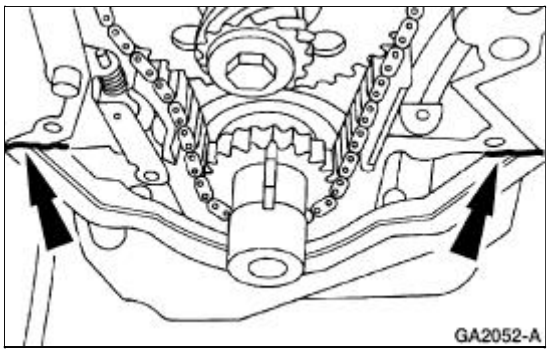
   CAUTION: Do not use a surface conditioning pad or any other type of fibrous abrasive disc to clean the gasket surfaces. Failure to follow these directions will result in engine damage.

   Clean and inspect the engine block and front cover as follows:

   - Pack the exposed portion of the oil pan with clean shop towels.
   - Plug the oil and coolant passages.
   - Clean the gasket surfaces.
   - Clean all surfaces requiring gasket sealant with metal surface cleaner.
   - Using compressed air, remove any remaining foreign material from the engine block and engine front cover.
   - Remove the shop towels from the oil pan.
   - Remove the plugs or seals from the engine block and engine front cover.

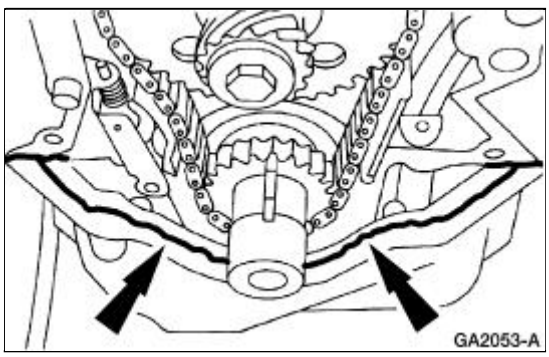
2. **NOTE:** If the engine front cover is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.

   Apply a small amount of silicone gasket and sealant as shown.

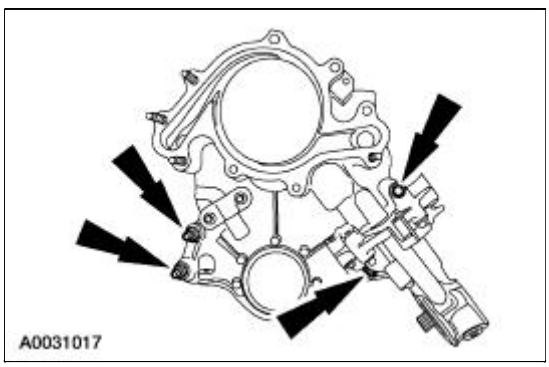


3. **NOTE:** If the engine front cover is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.

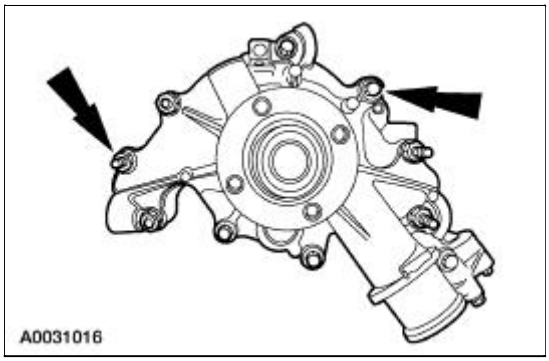
   Install the engine front cover gasket and apply silicone gasket and sealant as shown.



4. Install the engine front cover and bolts.

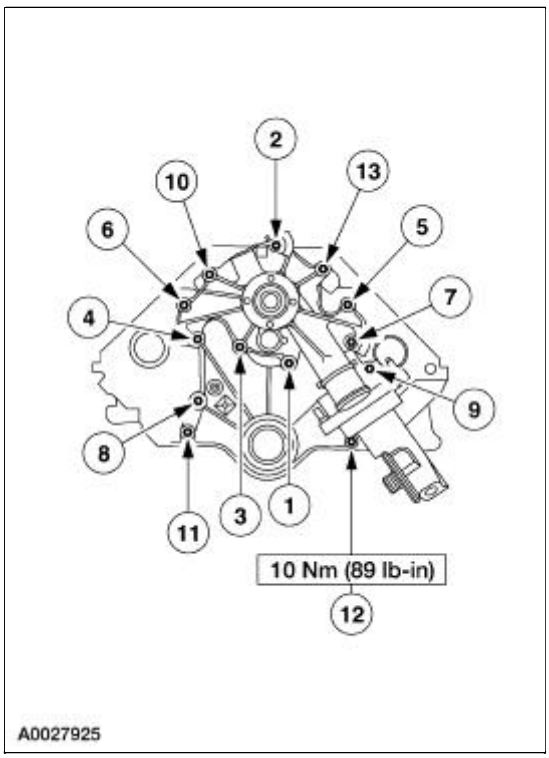


5. Install the water pump. Install the nuts and bolts.

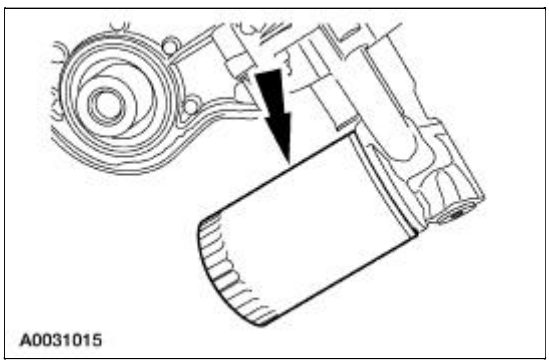


6. **NOTE:** The number 12 bolt is not part of the tightening sequence.

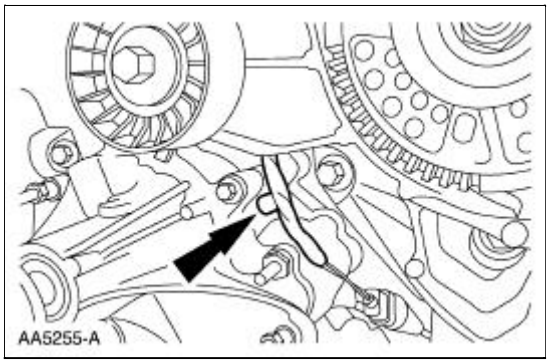
   Tighten the fasteners to 26 Nm (19 lb-ft) in the sequence shown.



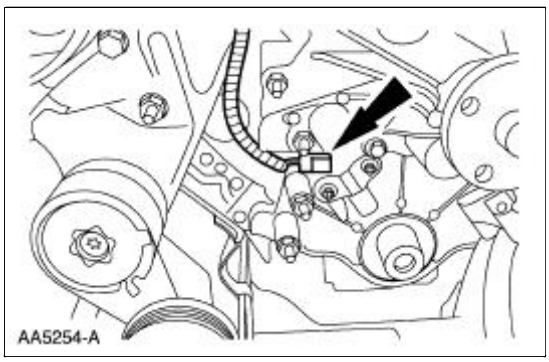
7. Install a new oil filter.



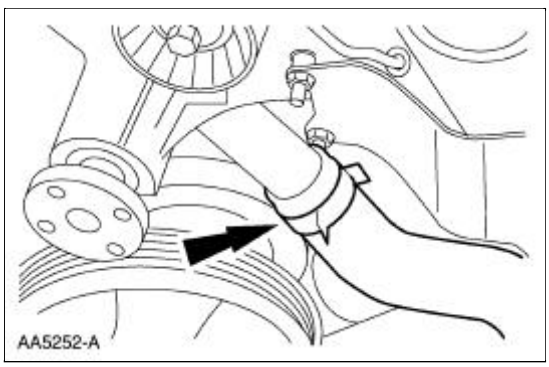
8. Install the wiring harness pin-type retainer.



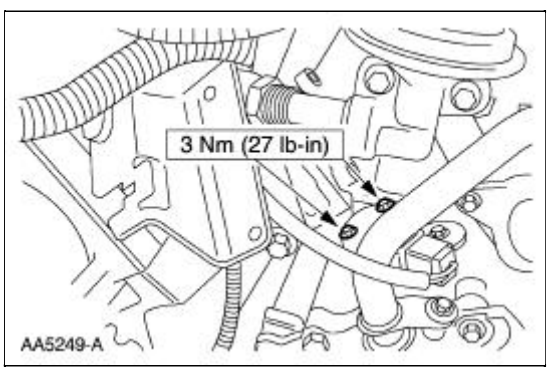
9. Connect the crankshaft position sensor electrical connector.



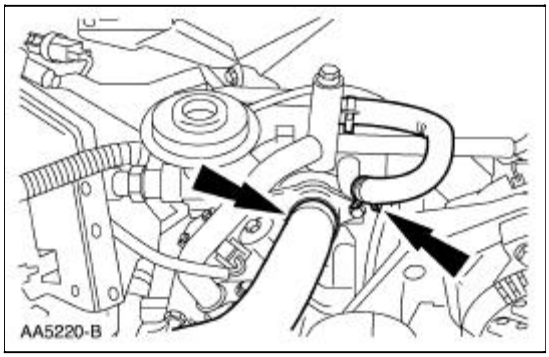
10. Connect the lower radiator hose.



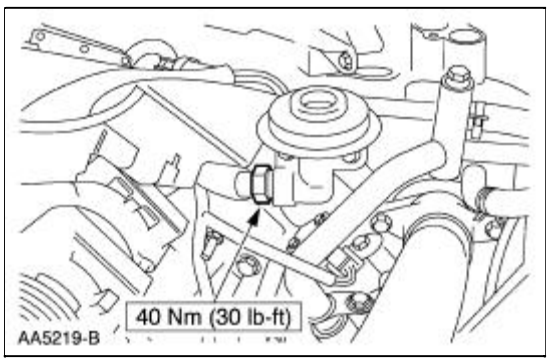
11. Install the camshaft synchronizer assembly. For additional information, refer to Section 303-14 .
12. Install the heater water outlet tube. For additional information, refer to Section 303-13 .
13. Install the camshaft position (CMP) sensor, and connect the electrical connector.



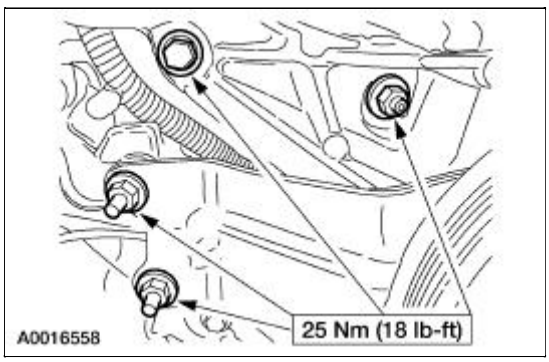
14. Connect the bypass hose and the upper radiator hose.



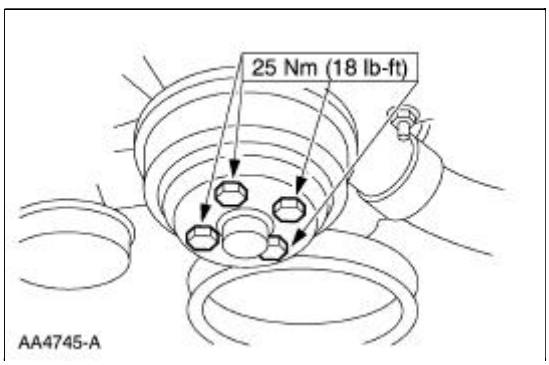
15. Connect the EGR tube.



16. Install the power steering pump.



17. Install the water pump pulley.



18. Install the crankshaft pulley. For additional information, refer to Crankshaft Pulley in this section.

19. Drain the engine oil and fill with clean engine oil.
20. Fill the engine cooling system. For additional information, refer to Section 303-03A .
21. Connect the battery ground cable. For additional information, refer to Section 414-01 .

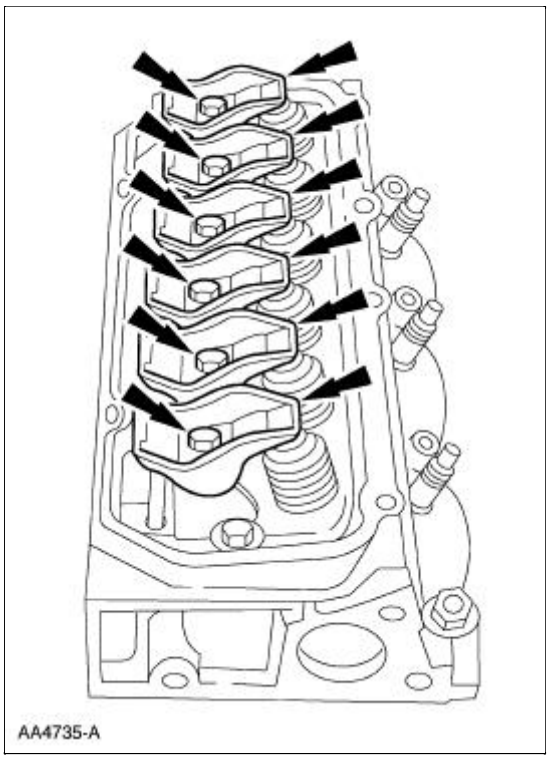
Rocker Arm

Removal

CAUTION: If removing more than one rocker arm (6564), mark the components removed for correct location.

1. Remove the valve covers. For additional information, refer to Valve Cover—LH and Valve Cover RH in this section.

2. Remove the rocker arm assembly.
   - Remove the bolt.



Installation

1. Install the rocker arms, tighten the bolts in two stages.
   - Stage 1: tighten to 5 Nm (44-lb-in).
   - Stage 2: tighten to 35 Nm (26 lb-ft).

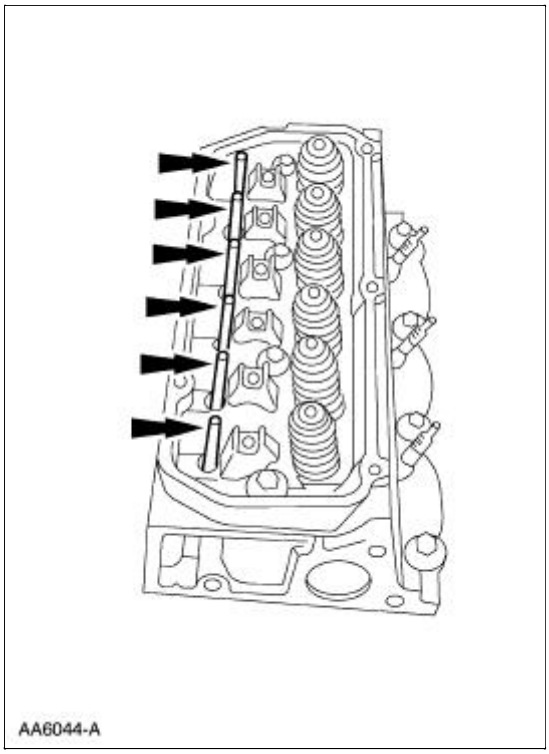
2. Install the valve covers. For additional information, refer to Valve Cover—LH and Valve Cover RH in this section.

Push Rod

Removal

CAUTION: Mark the components removed for correct location.

1. Remove the rocker arms (6564). For additional information, refer to Rocker Arm in this section.
2. Remove the push rods (6565).



3. Inspect the components. For additional information, refer to Section 303-00 .

Installation

1. To install, reverse the removal procedure.

Valve Springs

Special Tool(s)

ST1383-A	Compressor, Valve Spring 303-163 (T81P-6513-A)

Material

Item	Specification
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Removal

1. Remove the LH and the RH valve covers. For additional information, refer to Valve Cover—LH and Valve Cover RH in this section.

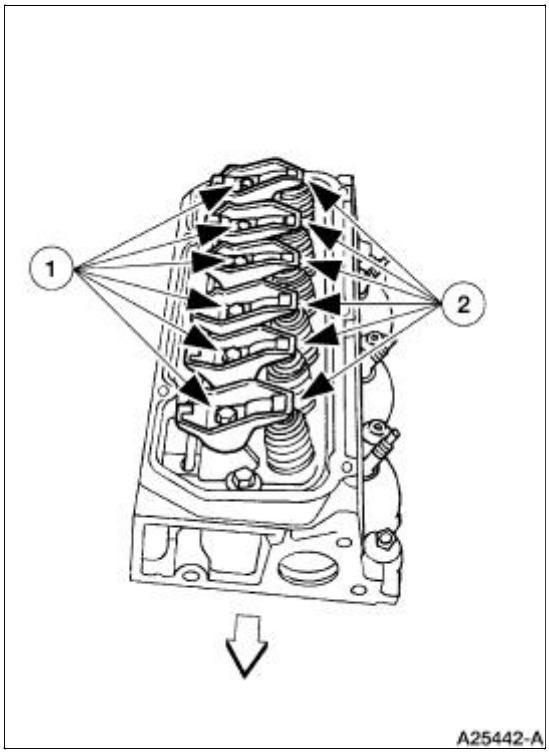
2. Rotate the crankshaft until the piston for the valve being worked on is at the top of its stroke with both the intake valve and the exhaust valve closed.

3. Hold the valve in the cylinder head.
   - Remove the spark plug. For additional information, refer to Section 303-07A .
   - Apply a minimum of 965 kPa (140 psi) of compressed air into the cylinder.

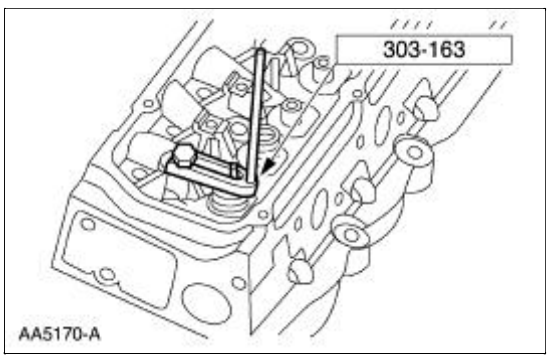
4. **CAUTION: If the components are to be reinstalled, they must be installed in the same position. Mark the components for location.**

   NOTE: If a valve drops into the cylinder, remove the cylinder head. For additional information, refer to Cylinder Head LH or Cylinder Head RH in this section.

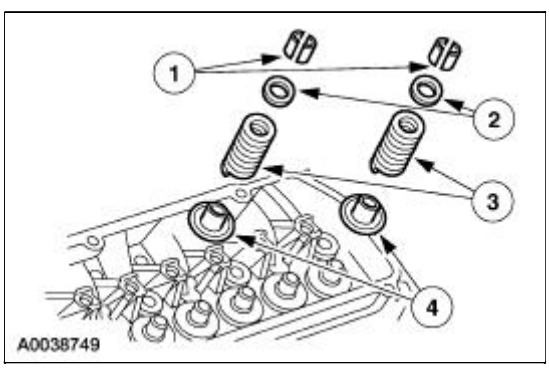
   Remove the rocker arms.
   1. Remove the bolts.
   2. Remove the rocker arms.



5. Using the special tool, compress the valve springs.



6. Remove the valve spring assembly.
    1. Remove the valve spring retainer key.
    2. Remove the valve spring retainer.
    3. Remove the valve spring.
    4. Remove and discard the valve stem seal and spring seat assembly.

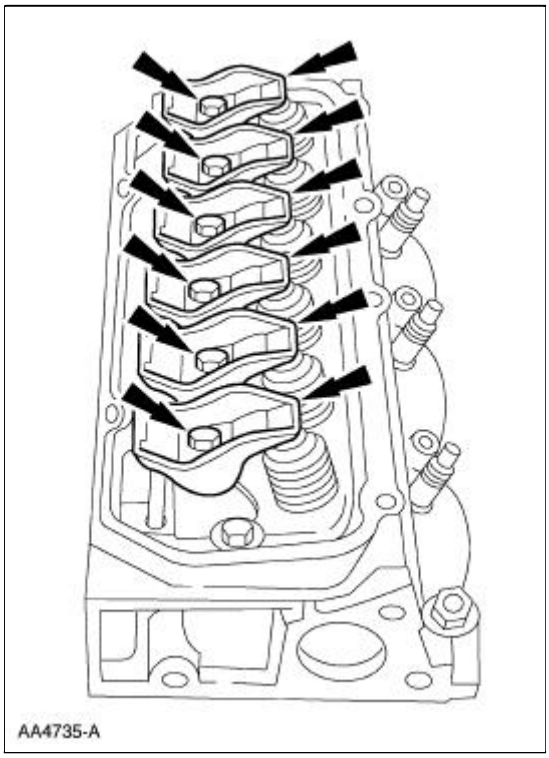


7. Inspect the components. For additional information, refer to Section 303-00 .

Installation

1. **NOTE:** Lubricate the parts with clean engine oil.

   To install, reverse the removal procedure. Tighten the rocker arm bolts in two stages.
   - Stage 1: Tighten to 5 Nm (44 lb-in).
   - Stage 2: Tighten to 35 Nm (26 lb-ft).



Valve Tappets

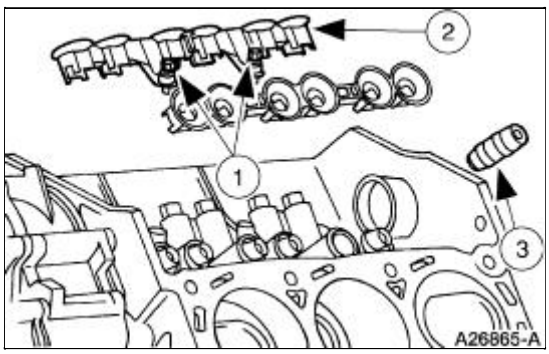
Material

Item	Specification
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Removal

CAUTION: If removing more than one valve tappet, mark the components removed for correct location.

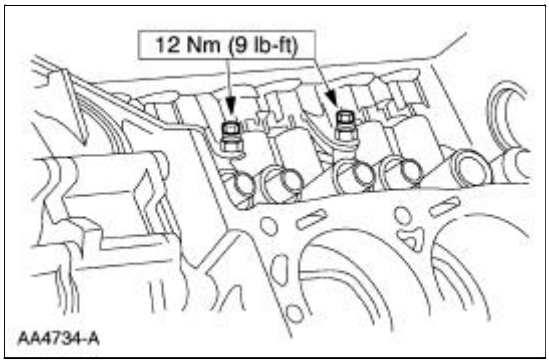
1. Remove the lower intake manifold. For additional information, refer to Lower Intake Manifold in this section.
2. Remove the push rods. For additional information, refer to Push Rod .
3. Remove the eight valve tappets.
   1. Remove the bolts.
   2. Remove the tappet guide plate and retainer.
   3. Remove the valve tappets.



Installation

1. **NOTE:** Lubricate the valve tappet with clean engine oil before installing.

   To install, reverse the removal procedure.


12 Nm (9 lb-ft)
AA4734-A

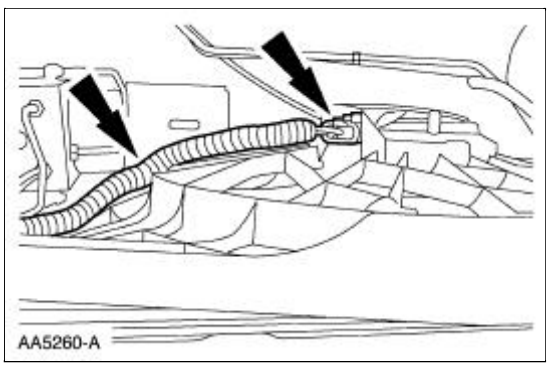
Camshaft

Material

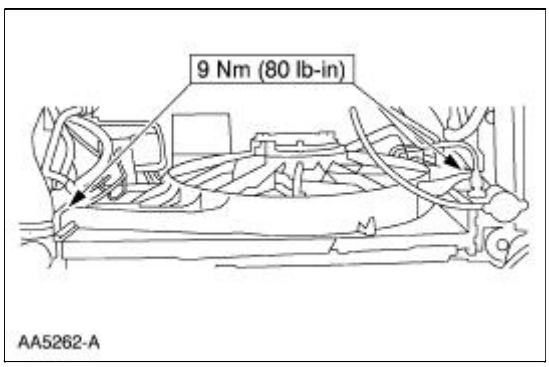
Item	Specification
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Removal

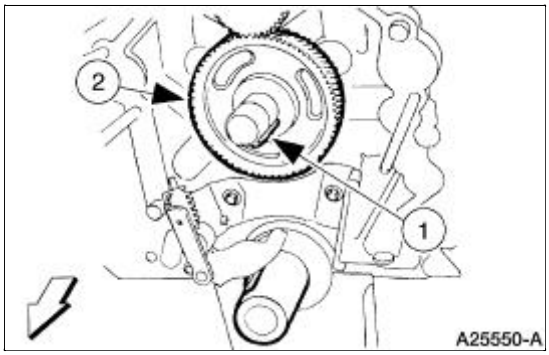
1. Remove the valve tappets. For additional information, refer to Valve Tappets in this section.
2. Remove the timing chain. For additional information, refer to Timing Chain in this section.
3. Position the wire harness aside.



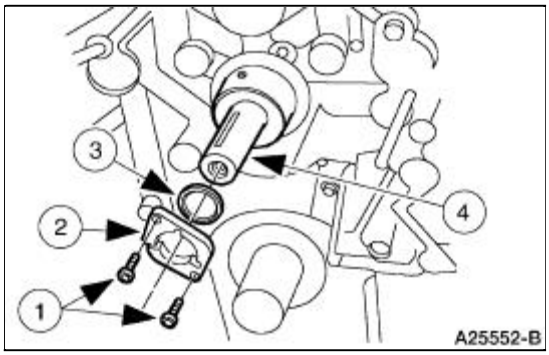
4. Remove the radiator fan and shroud assembly.



5. Remove the engine balance shaft drive gear from the camshaft.
   1. Remove the camshaft key.
   2. Remove the engine balance shaft drive gear.



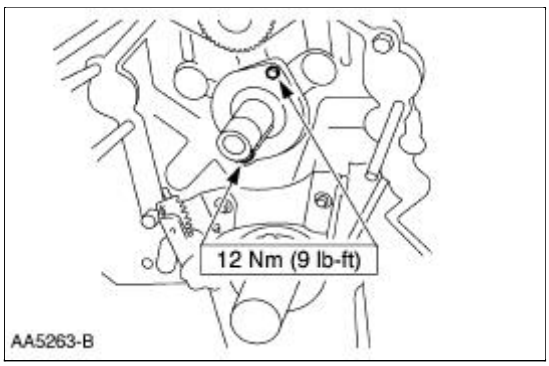
6. Remove the camshaft.
    1. Remove the bolts.
    2. Remove the camshaft thrust plate.
    3. Remove the spacer.
    4. Remove the camshaft.



Installation

1. **NOTE:** Lubricate the camshaft with clean engine oil prior to installation.

    To install, reverse the removal procedure.

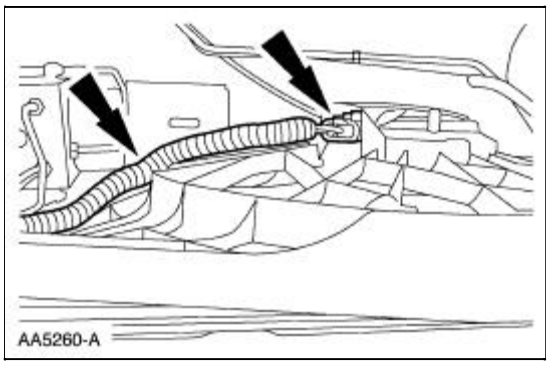


Engine Dynamic Balance Shaft

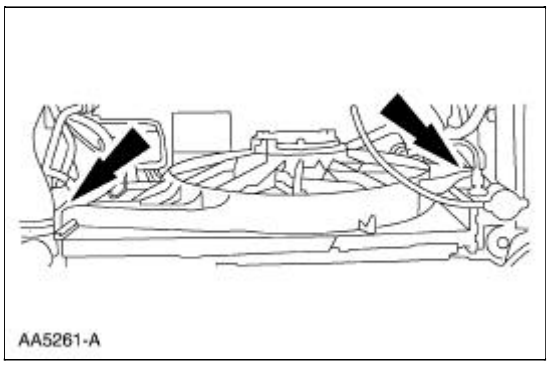
Removal

1. Remove the timing chain (6268). For additional information, refer to Timing Chain in this section.

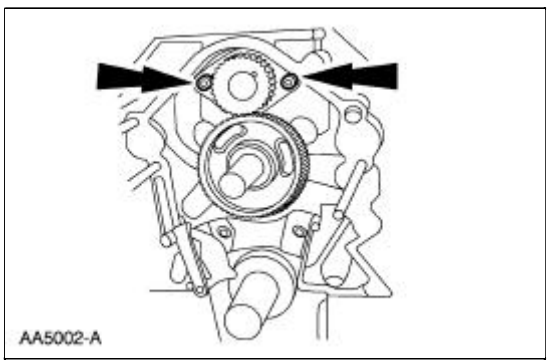
2. Disconnect and position the wire harness aside.



3. Remove the radiator fan and shroud assembly (8146).

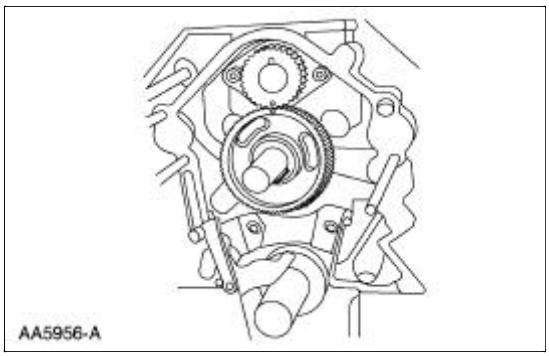


4. Remove the engine dynamic balance shaft (6A311).
   - Remove the bolts.
   - Remove the balance shaft driver gear, thrust plate and engine dynamic balance shaft as an assembly.



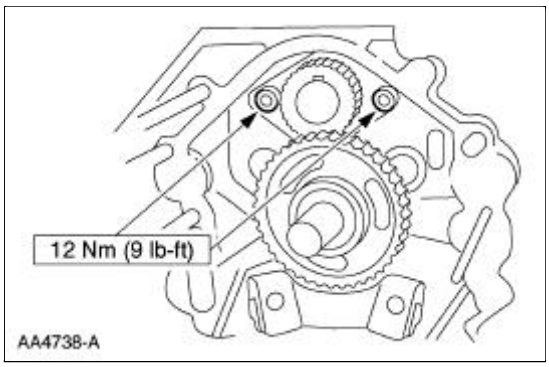
Installation

1. Turn the camshaft so that the timing mark is at 12 o'clock and install the engine dynamic balance shaft assembly into the cylinder block (6010). Turn the engine balance shaft driven gear so that the timing mark lines up with the timing mark on the engine balance shaft drive gear (6A303).

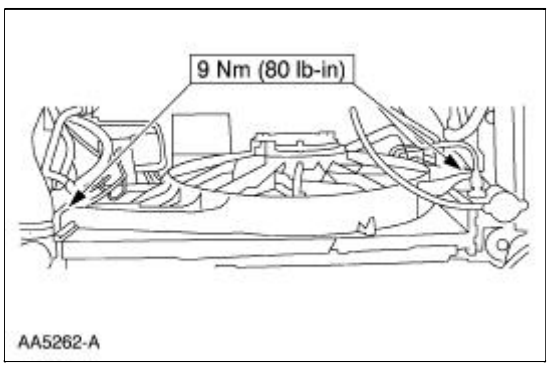


2. **NOTE:** If correctly aligned, the engine dynamic balance shaft keyway will be at 12 o'clock and the camshaft keyway will be at 6 o'clock on the camshaft.

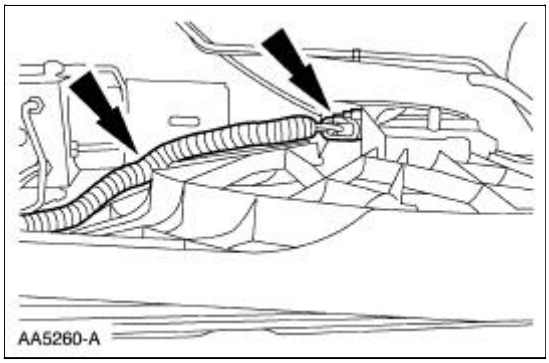
   Install the bolts.



3. Install the radiator fan and shroud assembly.



4. Connect the connector and install the pin-type retainer.



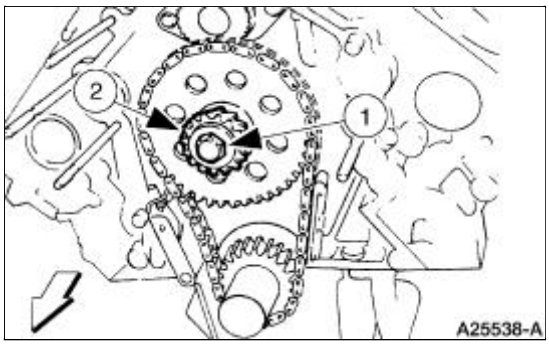
5. Install the timing chain. For additional information, refer to Timing Chain in this section.

Timing Chain

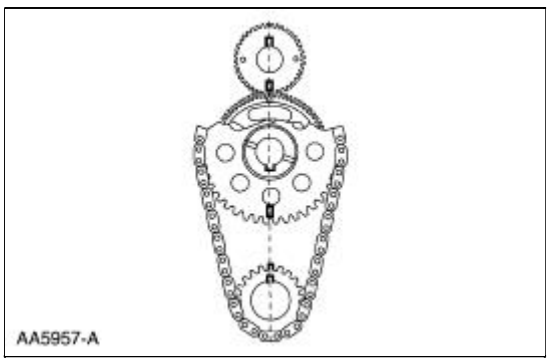
Removal

1. Remove the timing cover. For additional information, refer to Engine Front Cover in this section.

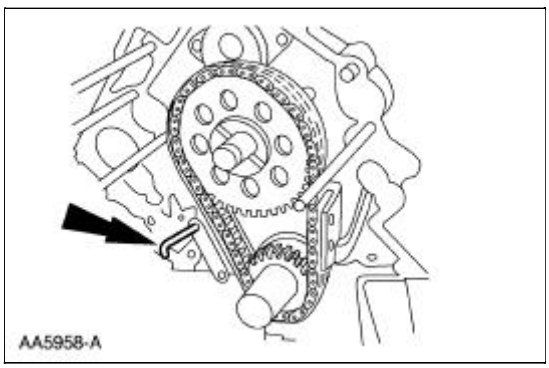
2. Remove the camshaft position sensor drive gear.
    1. Remove the bolt.
    2. Remove the camshaft position sensor drive gear.



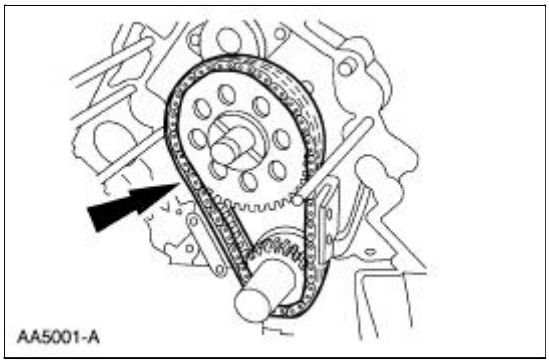
3. Rotate the crankshaft (6303) until the timing marks and keyways align.



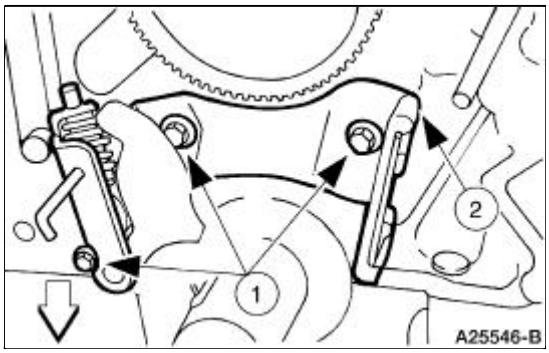
4. Compress and install a retaining pin to hold the timing chain tensioner (6L266).



5. Remove the camshaft sprocket (6256), the crankshaft sprocket (6306) and the timing chain/belt (6268) as an assembly.

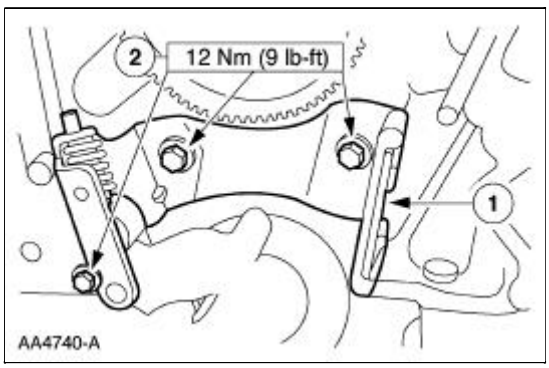


6. Remove the timing chain tensioner.
    1. Remove the bolts.
    2. Remove the timing chain tensioner.

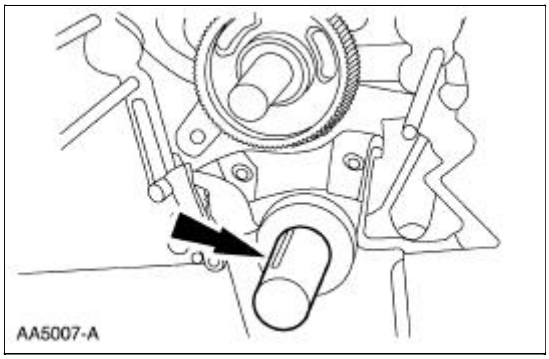


Installation

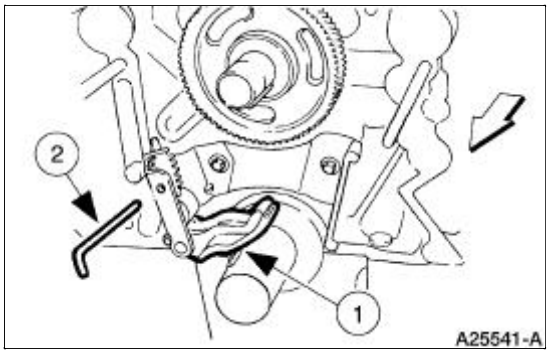
1. Install the timing chain tensioner.
    1. Position the timing chain tensioner.
    2. Install the bolts.



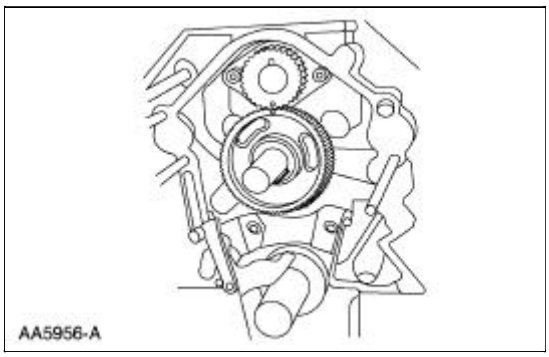
2. Rotate the crankshaft so the number one piston (6108) is at top dead center (TDC) and the key is at the 12 o'clock position.



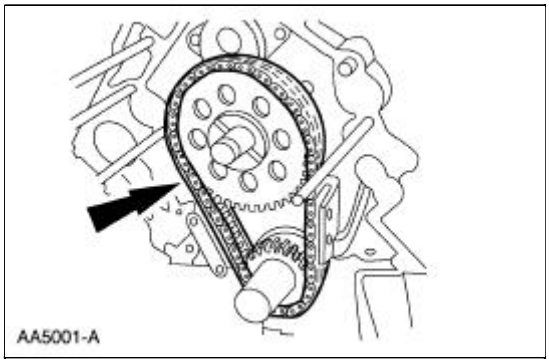
3. If necessary, retract the tensioner pad retracting mechanism.
    1. Compress the tensioner pad retracting mechanism.
    2. Insert a retaining pin.



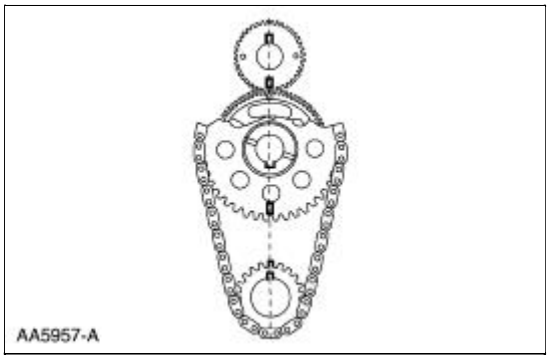
4. Turn the camshaft sprocket so that the timing mark is on the bottom of the balance shaft (6250).



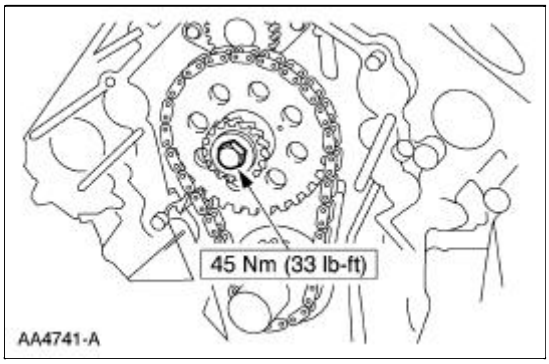
5. Install the timing chain, the camshaft sprocket and the crankshaft sprocket.



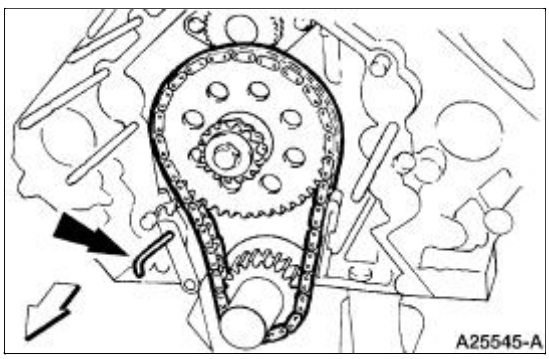
6. Make sure that the timing marks and the keyways are aligned.



7. Install the camshaft position sensor drive gear.



8. Remove the retaining pin.

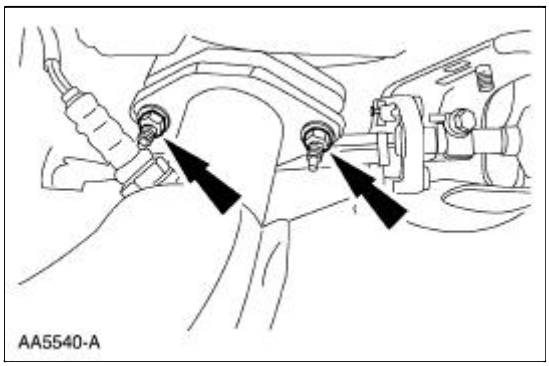


9. Install the engine front cover. For additional information, refer to Engine Front Cover in this section.

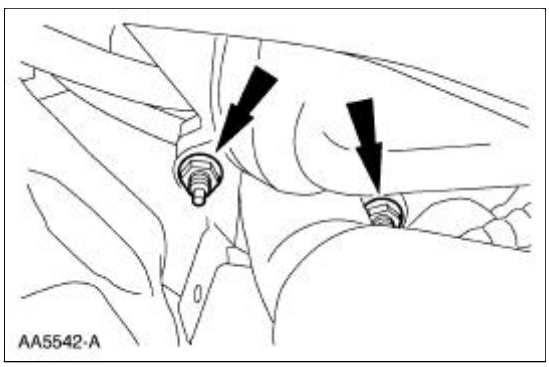
Exhaust Manifold —LH

Removal

1. Raise and support the vehicle. For additional information, refer to Section 100-02 .
2. Remove the LH exhaust manifold flange nuts.

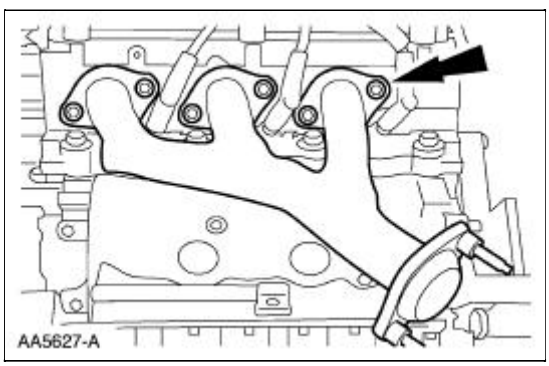


3. Remove the RH exhaust manifold flange nuts.



4. Lower the vehicle.
5. **NOTE:** Discard the exhaust manifold gasket.

   Remove the LH exhaust manifold (9431).
   - Remove the nuts.

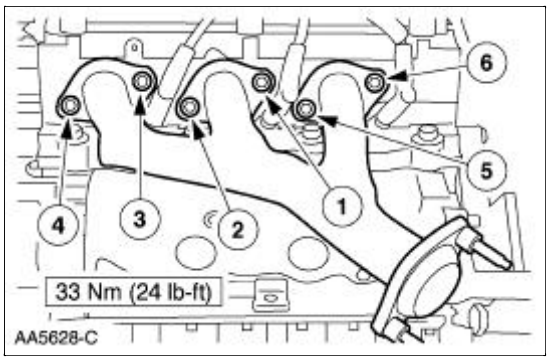


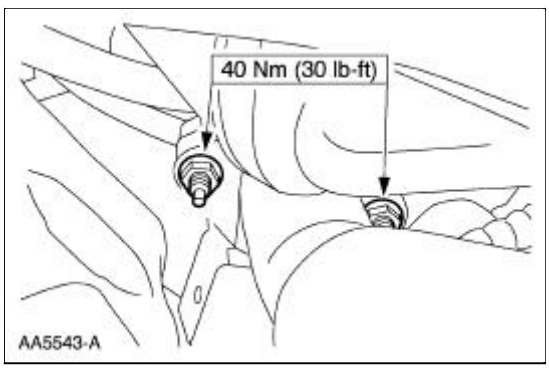
Installation

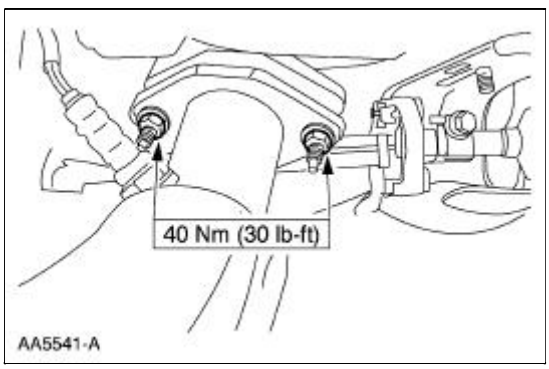
1. **NOTE:** Install a new gasket.

   NOTE: Tighten the nuts in the sequence shown.

   To install, reverse the removal procedure.



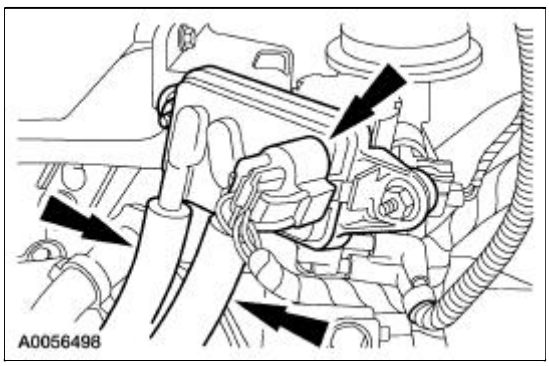




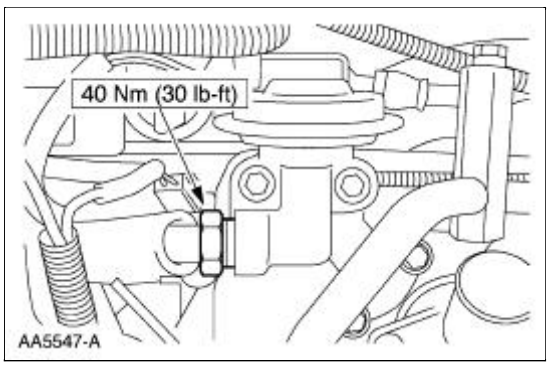
Exhaust Manifold RH

Removal and Installation

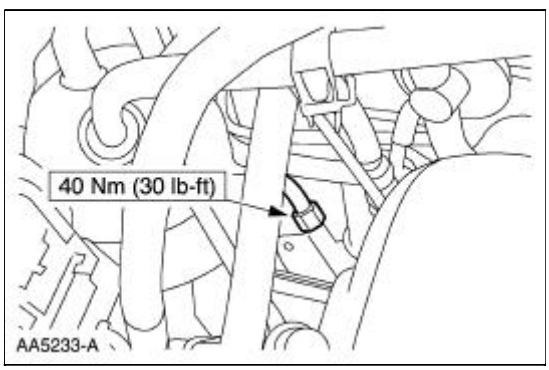
1. Disconnect the battery negative cable. For additional information, refer to Section 414-01 .
2. Remove the air cleaner outlet pipe. For additional information, refer to Section 303-12 .
3. Disconnect the differential pressure feedback exhaust gas recirculation (EGR) system electrical and vacuum connections.



4. Disconnect the EGR tube.

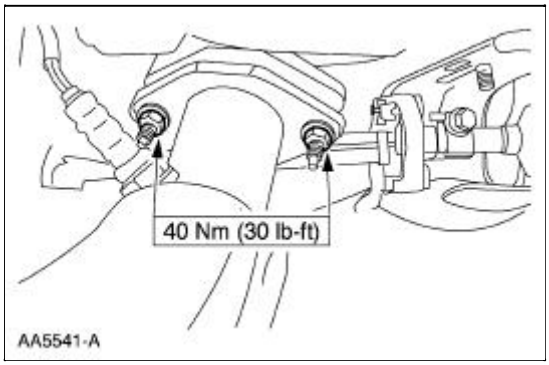


5. Remove the EGR tube.

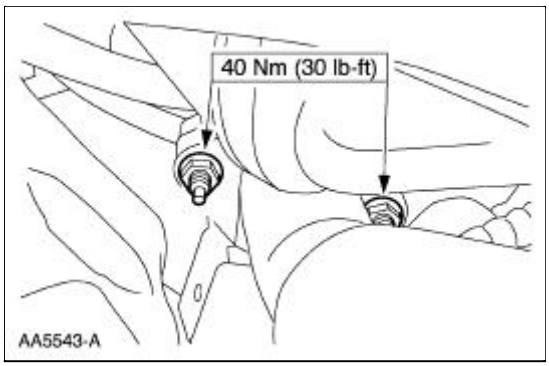


6. Raise and support the vehicle. For additional information, refer to Section 100-02 .

7. Remove the LH exhaust manifold flange nuts.



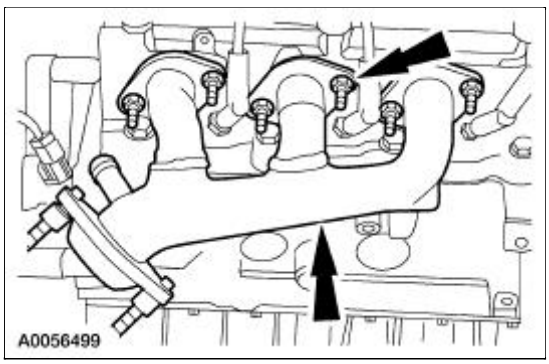
8. Remove the RH exhaust manifold flange nuts.



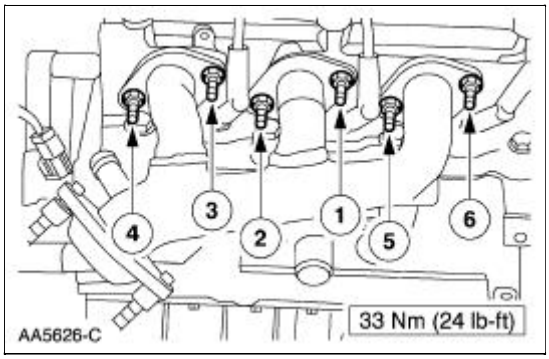
9. Lower the vehicle.

10. **NOTE:** Discard the exhaust manifold gasket.

    Remove the RH exhaust manifold retaining nuts and the RH exhaust manifold.



11. To install, reverse the removal procedure. Tighten the exhaust manifold nuts in the sequence shown.


4
3
2
1
5
6
33 Nm (24 lb-ft)
AA5626-C

Cylinder Head LH

Special Tool(s)

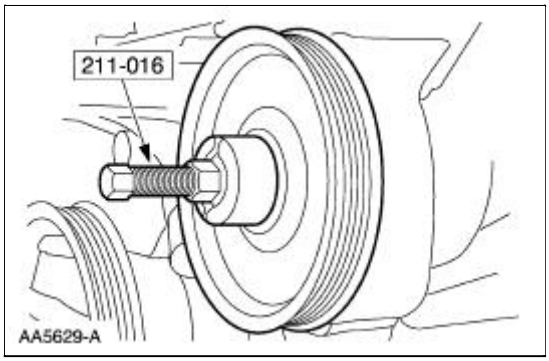
ST1290-B	Remover, Power Steering Pump Pulley 211-016 (T69L-10300-B)
	Installer, Power Steering Pump Pulley 211-009

Material

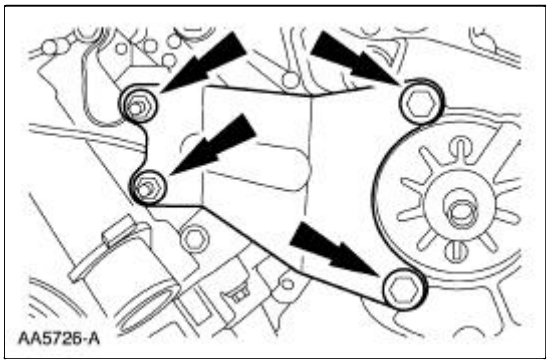
Item	Specification
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Removal

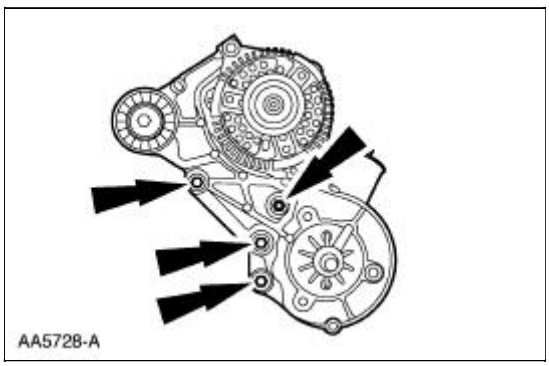
1. Disconnect the battery negative cable. For additional information, refer to Section 414-01 .
2. Drain the engine cooling system. For additional information, refer to Section 303-03A .
3. Remove the LH exhaust manifold. For additional information, refer to Exhaust Manifold—LH in this section.
4. Remove the lower intake manifold. For additional information, refer to Lower Intake Manifold in this section.
5. Remove the push rods. For additional information, refer to Push Rod in this section.
6. Remove the drive belt. For additional information, refer to Section 303-05 .
7. Using the special tool, remove the power steering pump pulley.



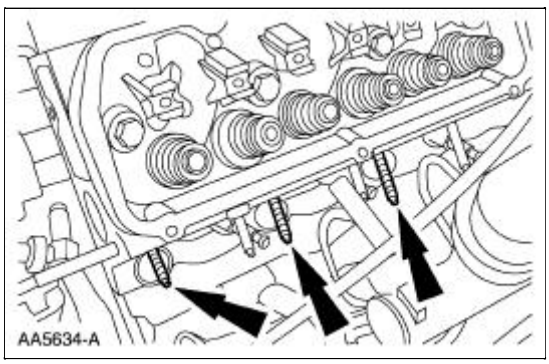
8. Remove the power steering pump bracket.



9. Remove the generator bracket.



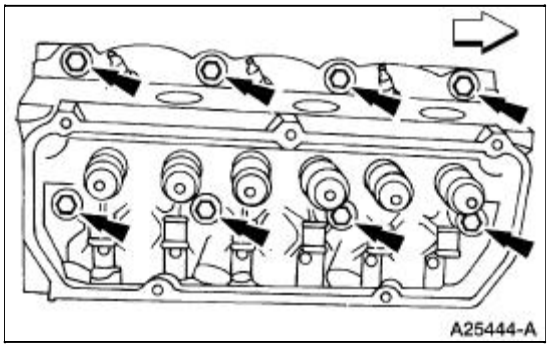
10. Remove the three exhaust manifold studs.



11. **NOTE:** Discard the cylinder head gasket.

    NOTE: Record the location of the long bolts and the short bolts.

Remove the cylinder head. Discard the cylinder head bolts.



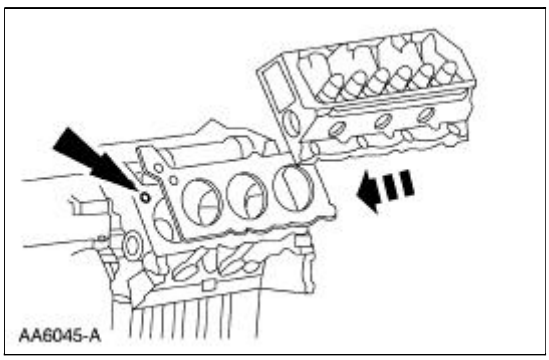
Installation

NOTE: Do not use a fiber disc to clean the surfaces. Fibers from the disc can get into the oil pan and oil and clog the oil bypass valve.

1. Clean and inspect the cylinder head for flatness. For additional information, refer to Section 303-00 .

2. Install a new head gasket on the cylinder block with the small hole to the front of the engine.

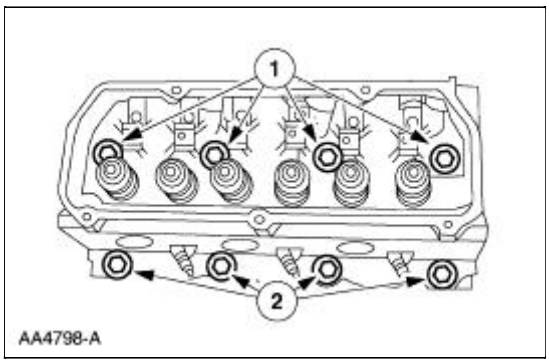
3. Position the cylinder head.



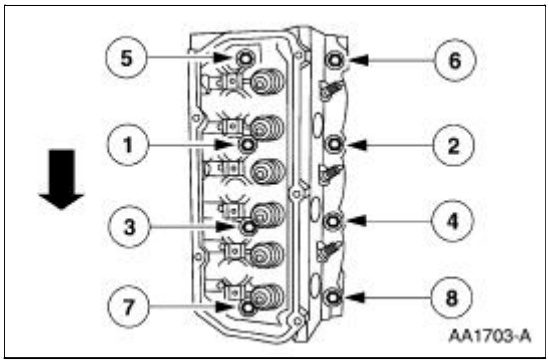
4. **CAUTION: Always use new bolts.**

   NOTE: Lubricate the bolts with clean engine oil.

   Install new bolts. Refer to the location note made during removal and make sure the bolts are installed the correct location.
   1. Install the new long bolts.
   2. Install the new short bolts.



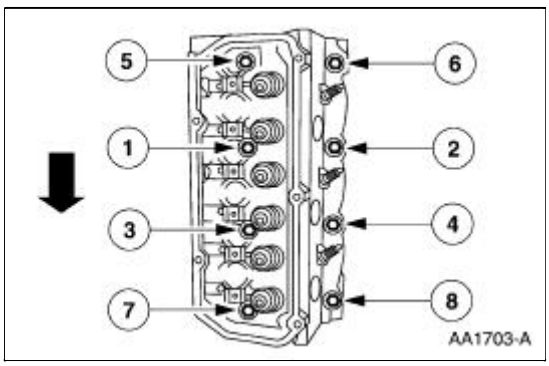
5. Tighten the bolts in three stages in the sequence shown.
    - Stage 1: Tighten the bolts to 20 Nm (15 lb-ft).
    - Stage 2: Tighten the bolts to 40 Nm (30 lb-ft).
    - Stage 3: Tighten the bolts to 50 Nm (37 lb-ft).



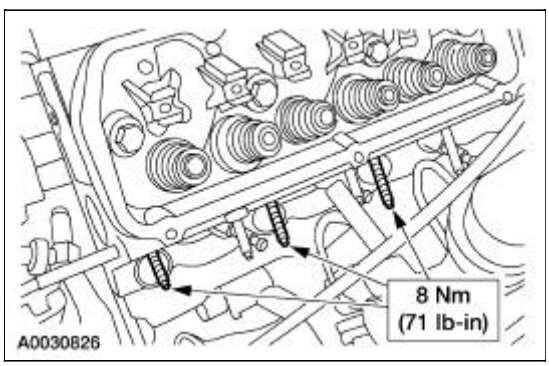
6. **CAUTION: Do not loosen all of the bolts at one time. Each bolt must be loosened and final-tightened prior to working on the next bolt in the sequence.**

    NOTE: The short bolts are numbered 2, 4, 6 and 8 and the long bolts numbered 1, 3, 5 and 7.

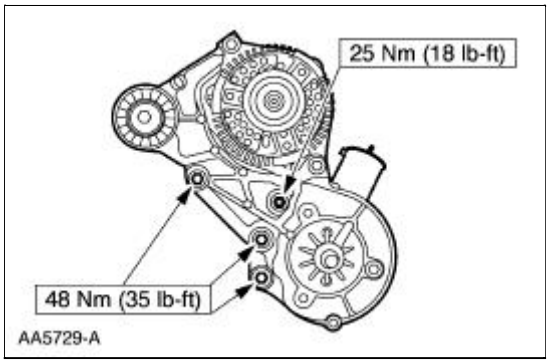
    Loosen, then tighten the bolts in two stages in the sequence shown.
    - Stage 1: Tighten short bolts to 25 Nm (18 lb-ft), then tighten an additional 180 degrees.
    - Stage 1: Tighten long bolts to 45 Nm (33 lb-ft), then tighten an additional 180 degrees.



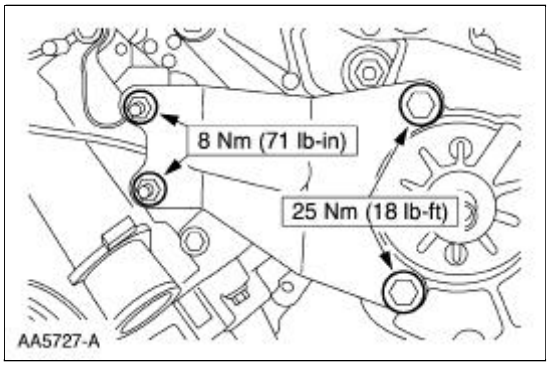
7. Install the exhaust manifold studs.



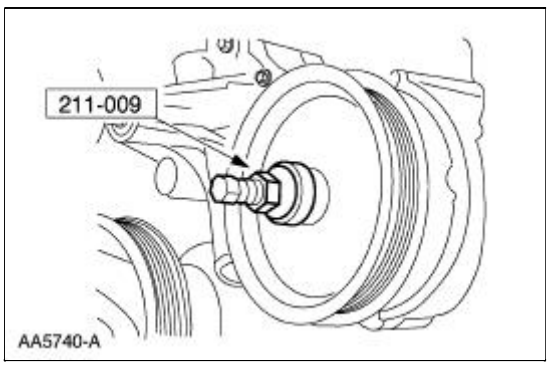
8. Install the bracket and bolts.



9. Install the support bracket.



10. Using the special tool, install the power steering pump pulley.



11. Install the drive belt. For additional information, refer to Section 303-05 .

12. Install the push rods. For additional information, refer to Push Rod in this section.

13. Install the lower intake manifold. For additional information, refer to Lower Intake Manifold in this section.

14. Install the LH exhaust manifold. For additional information, refer to Exhaust Manifold—LH in this section.

15. Connect the battery ground cable. For additional information, refer to Section 414-01 .

16. **CAUTION: Correct cooling system bleeding is critical for correct engine cooling.**

    Fill and bleed the engine cooling system. For additional information, refer to Section 303-03A .

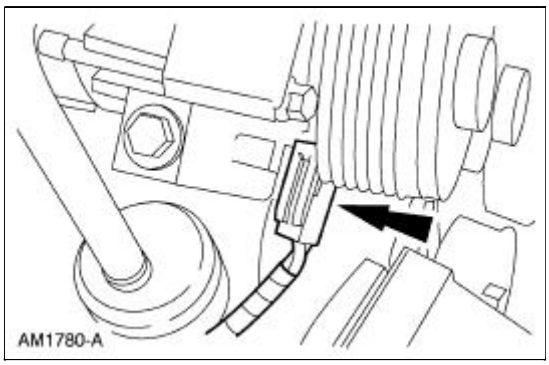
Cylinder Head RH

Material

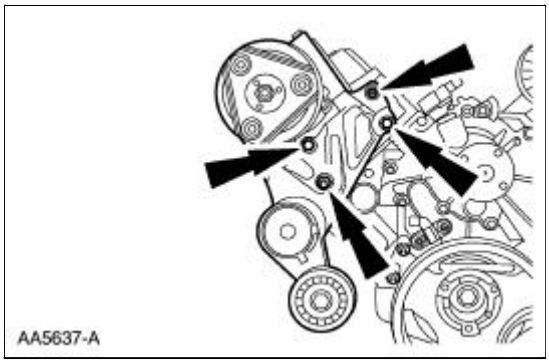
Item	Specification
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Removal

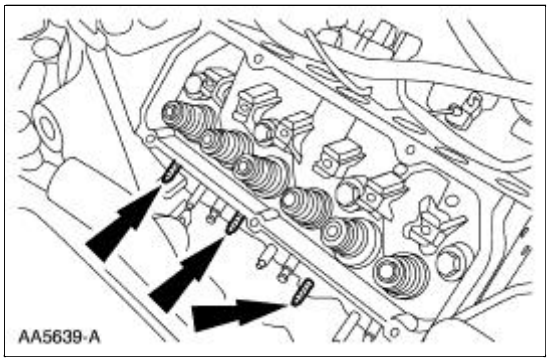
1. Disconnect the battery negative cable. For additional information, refer to Section 414-01 .
2. Drain the engine cooling system. For additional information, refer to Section 303-03A .
3. Remove the RH exhaust manifold. For additional information, refer to Exhaust Manifold RH in this section.
4. Remove the lower intake manifold. For additional information, refer to Lower Intake Manifold in this section.
5. Remove the push rods. For additional information, refer to Push Rod in this section.
6. Remove the drive belt. For additional information, refer to Section 303-05 .
7. Disconnect the A/C manifold and tube assembly. For additional information, refer to Section 412-03 .
8. Disconnect the A/C compressor clutch electrical connector.



9. Remove the A/C compressor bracket.



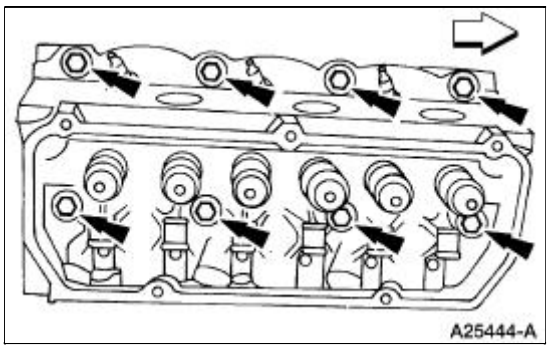
10. Remove the three exhaust manifold studs.



11. **NOTE:** Discard the cylinder head gasket.

    NOTE: Record the location of the long bolts and the short bolts.

    Remove the cylinder head. Discard the cylinder head bolts.

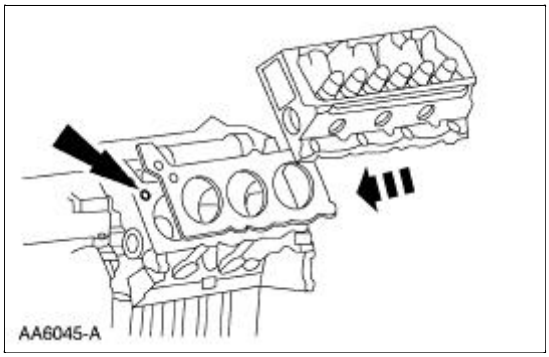


Installation

NOTE: Do not use a fiber disc to clean the surfaces. Fibers from the disc can get into the oil pan and oil and clog the oil bypass valve.

1. Clean and inspect the cylinder head for flatness. For additional information, refer to Section 303-00 .

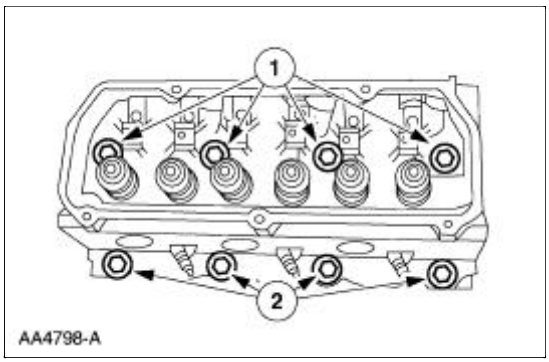
2. Install a new head gasket on the cylinder block with the small hole to the front of the engine and position the cylinder head.



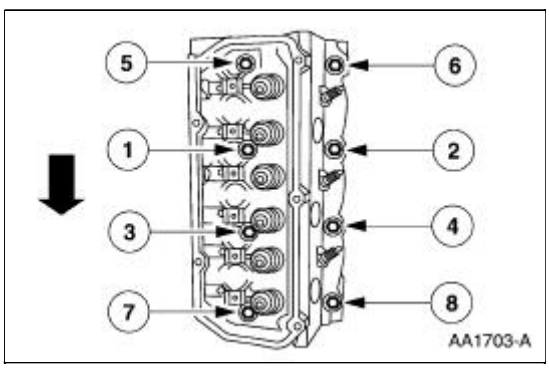
3. **CAUTION: Always use new bolts.**

   NOTE: Lubricate the bolts with clean engine oil.

   Install new bolts. Refer to the location note made during removal and make sure the bolts are installed the correct location.
   1. Install the new long bolts.
   2. Install the new short bolts.



4. Tighten the bolts in three stages in the sequence shown.
   - Stage 1: Tighten to 20 Nm (15 lb-ft).
   - Stage 2: Tighten to 40 Nm (30 lb-ft).
   - Stage 3: Tighten to 50 Nm (37 lb-ft).

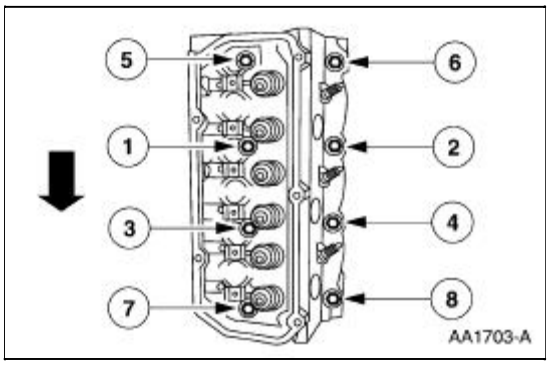


5. **CAUTION: Do not loosen all of the bolts at one time. Each bolt must be loosened and final-tightened prior to working on the next bolt in the sequence.**

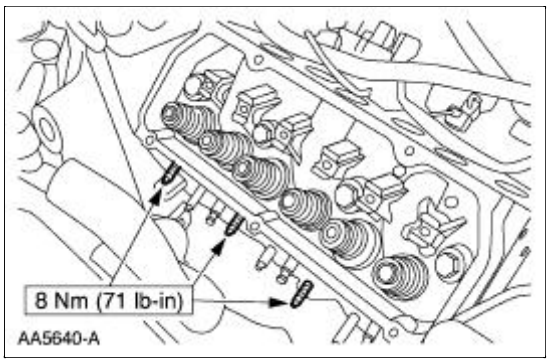
   NOTE: The short bolts are numbered 2, 4, 6 and 8 and the long bolts are numbered 1, 3, 5 and 7.

Loosen, then tighten the bolts in the sequence shown:

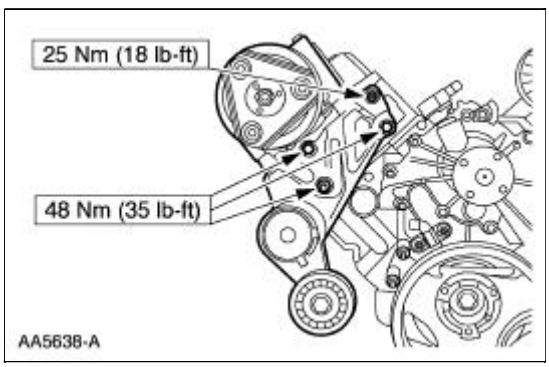
- Tighten short bolts to 25 Nm (18 lb-ft), then tighten an additional 180 degrees.
- Tighten long bolts to 45 Nm (33 lb-ft), then tighten an additional 180 degrees.



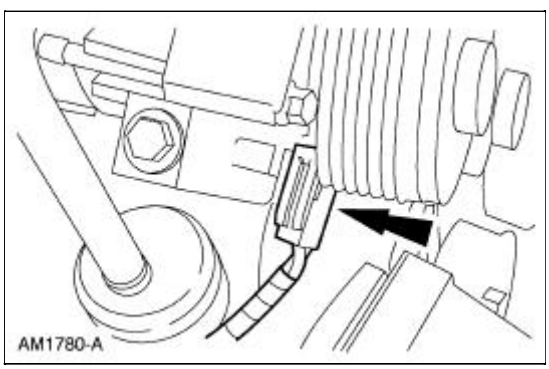
6. Install the three studs.



7. Install the bracket and bolts.



8. Connect the A/C compressor clutch electrical connector.



9. Connect the A/C manifold and tube assembly. For additional information, refer to Section 412-03 .

10. Install the accessory drive belt. For additional information, refer to Section 303-05 .

11. Install the push rods. For additional information, refer to Push Rod in this section.

12. Install the lower intake manifold. For additional information, refer to Lower Intake Manifold in this section.

13. Install the RH exhaust manifold. For additional information, refer to Exhaust Manifold RH in this section.

14. Connect the battery ground cable. For additional information, refer to Section 414-01 .

15. **CAUTION: Correct cooling system bleeding is critical for correct engine cooling.**

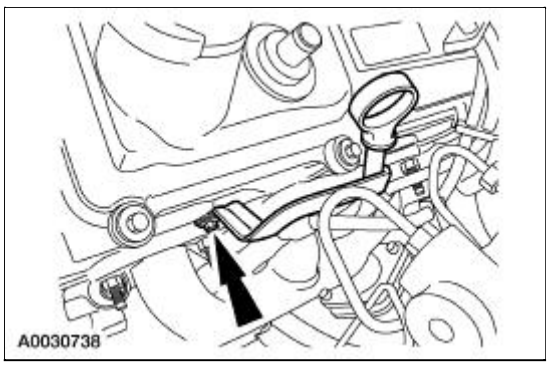
    Fill and bleed the engine cooling system. For additional information, refer to Section 303-03A .

16. Recharge the A/C refrigerant system. For additional information, refer to Section 412-00 .

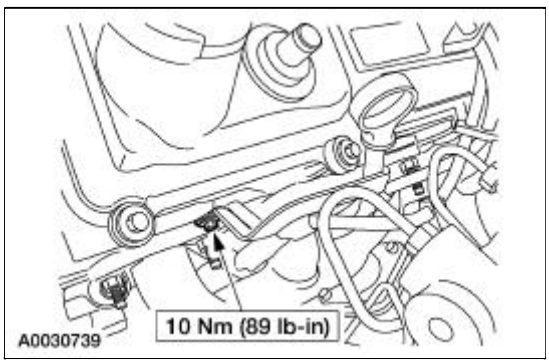
Oil Level Indicator and Tube

Removal and Installation

1. Remove the oil level indicator tube (6754).
   - Remove the bolt.
   - Remove the oil level indicator tube.
   - Remove and discard the oil level indicator tube O-ring.



2. To install, reverse the removal procedure.



Oil Pan

Special Tool(s)

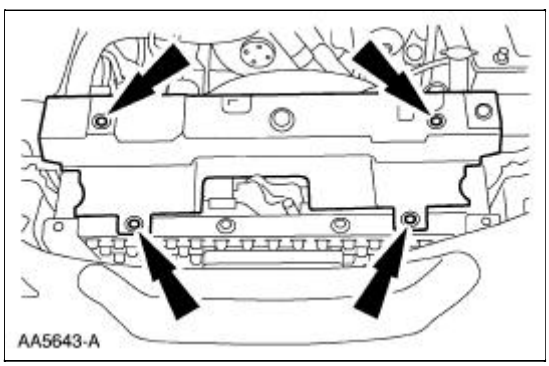
ST2333-A	3 Bar Engine Support Kit 303-F072
ST2375-A	Lifting Bracket Set, Engine 303-D095 (D94L-6001-A) or equivalent

Material

Item	Specification
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H
Metal Surface Cleaner F4AZ-19A536-RA or equivalent	WSE-M5B392-A
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4

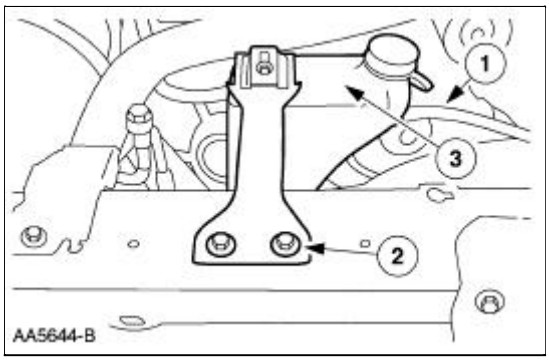
Removal

1. Disconnect the battery ground cable.
2. Remove the air cleaner outlet pipe. For additional information, refer to Section 303-12 .
3. Remove the radiator sight shield.

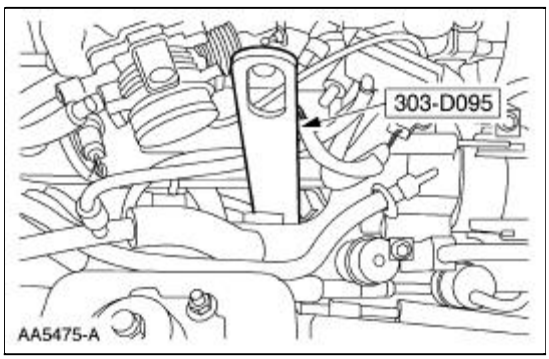


4. Remove the coolant recovery reservoir.
    1. Disconnect the hose.

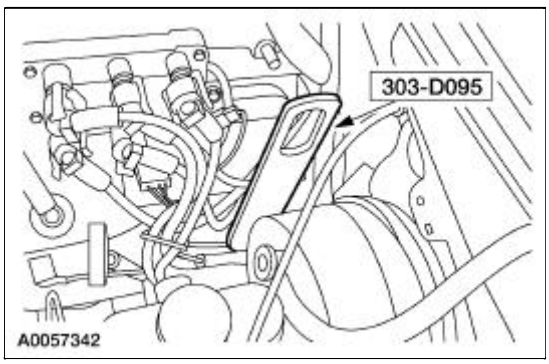
2. Remove the bolts.
3. Remove the coolant recovery reservoir.



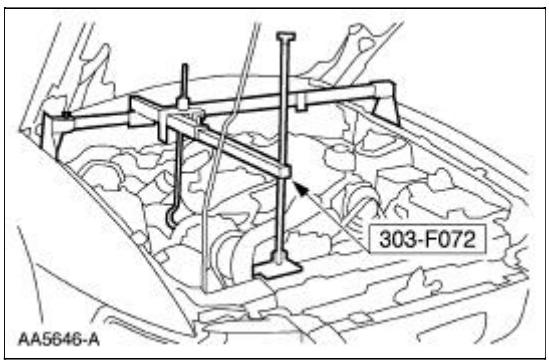
5. Install the special tool.



6. Install the special tool.

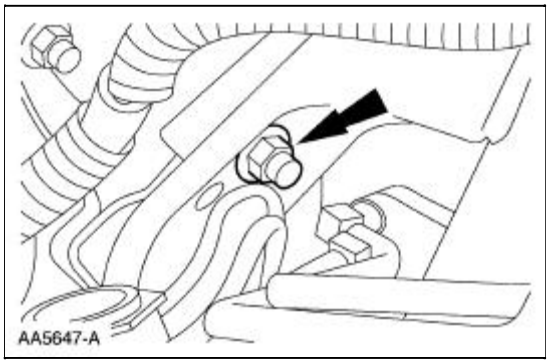


7. Install the special tool.

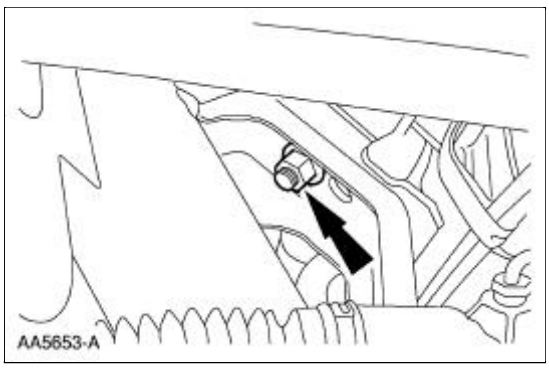


8. Raise and support the vehicle. For additional information, refer to Section 100-02 .

9. Remove the LH engine mount nut.

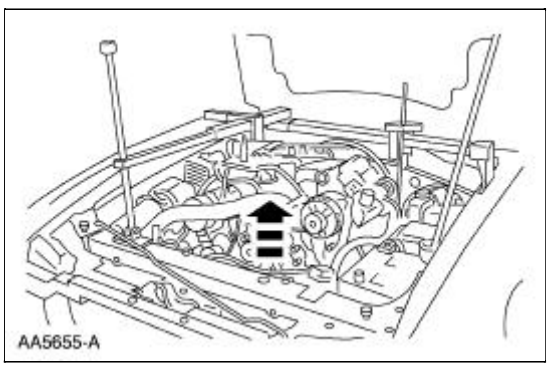


10. Remove the RH engine mount nut.



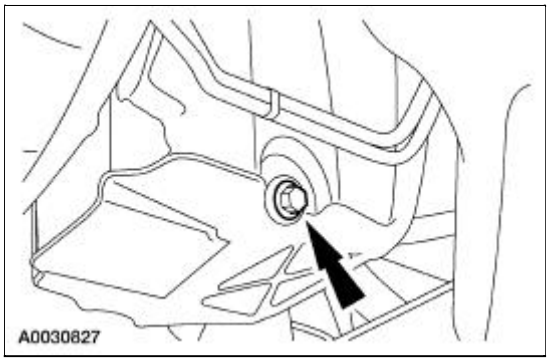
11. Lower the vehicle.

12. Raise the engine.



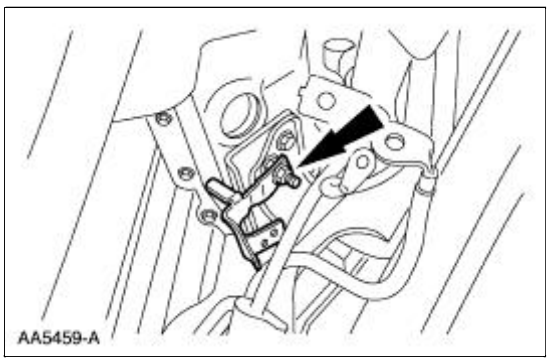
13. Raise and support the vehicle. For additional information, refer to Section 100-02 .

14. Remove the oil pan drain plug and drain the engine oil.

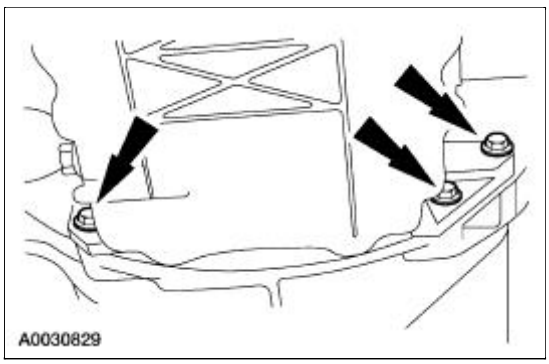


15. Remove the starter motor. For additional information, refer to Section 303-06 .

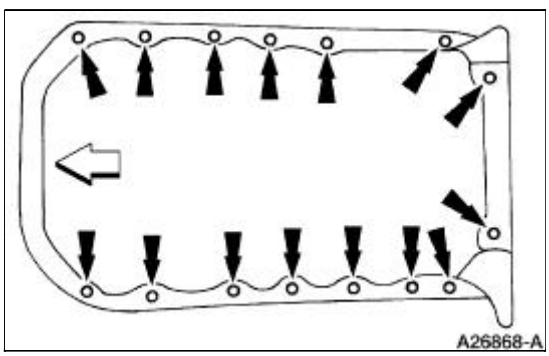
16. Position the wiring harness bracket aside.



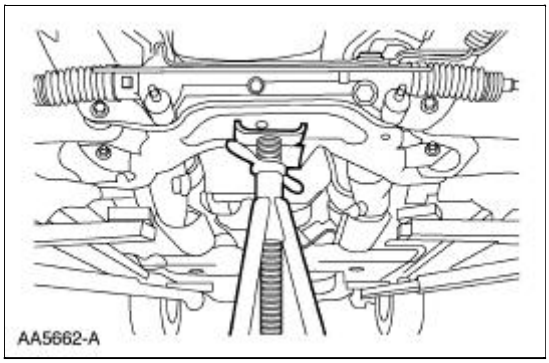
17. Remove the transmission lower bolts.



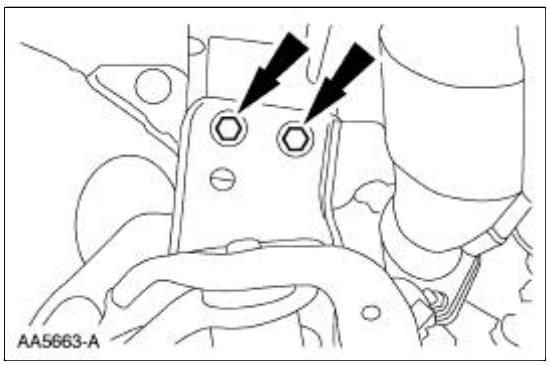
18. Remove the oil pan bolts.



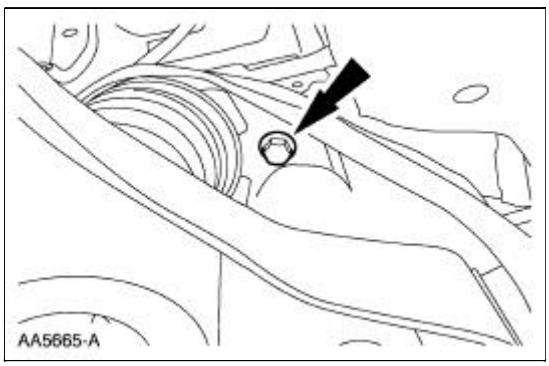
19. Position a safety stand under the subframe crossmember.



20. Remove the four subframe lower bolts.

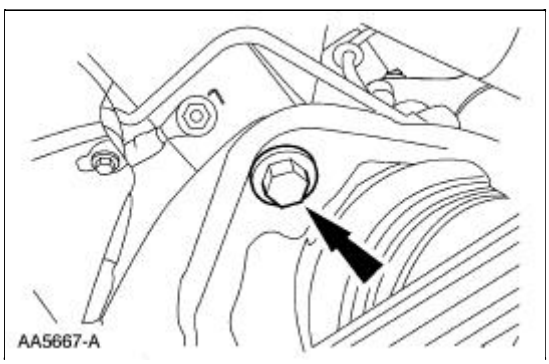


21. Remove the two subframe upper bolts.

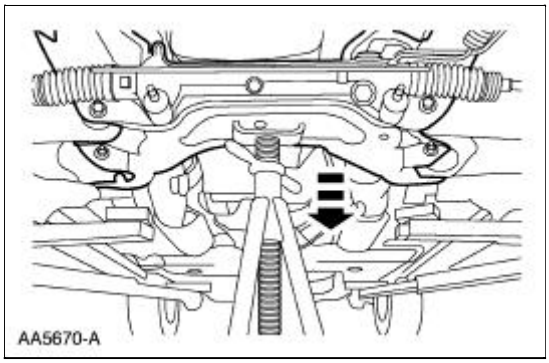


22. **NOTE:** Do not completely remove these bolts.

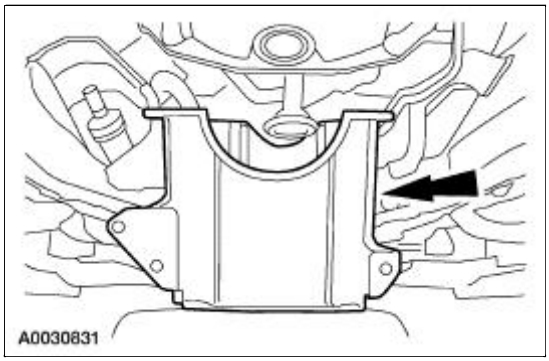
    Loosen the two bolts.



23. Lower the front subframe.



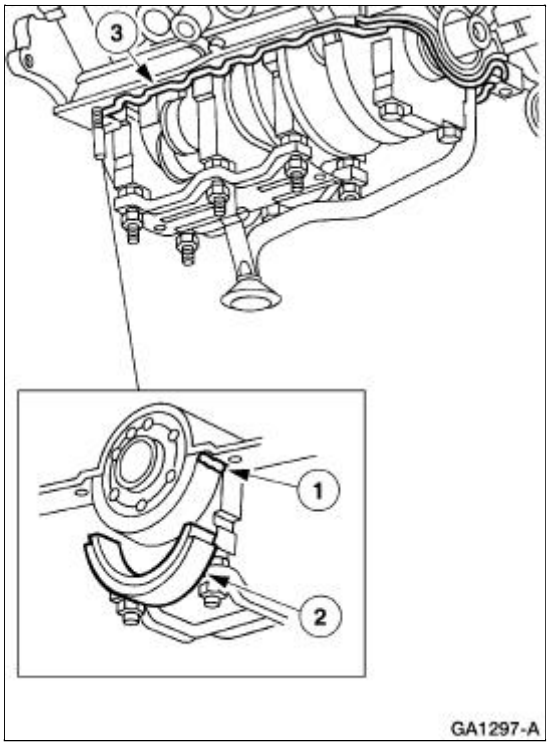
24. Remove the oil pan.



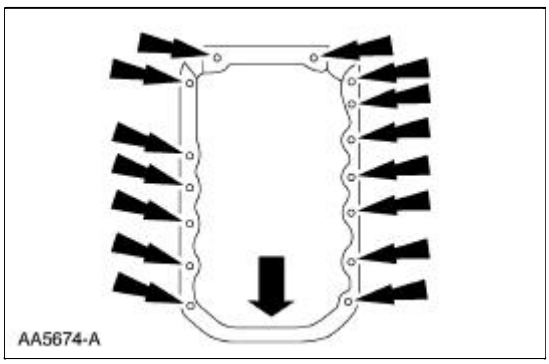
Installation

1. **NOTE:** If the oil pan is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.

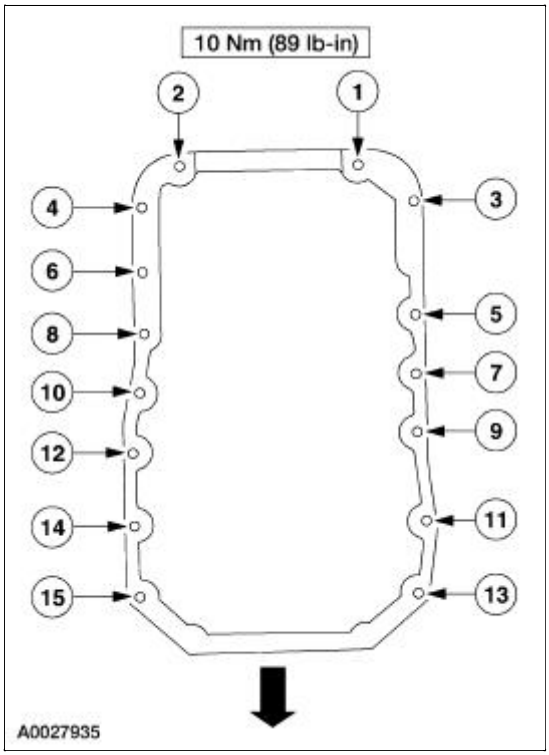
   Clean and apply sealant to the oil pan sealing areas shown and install the oil pan rear seal.
   1. Apply silicone gasket and sealant to the rear main bearing cap.
   2. Install the oil pan rear seal.
   3. Clean the oil pan mating surfaces with metal surface cleaner an apply silicone gasket and sealant to the oil pan mating surface.



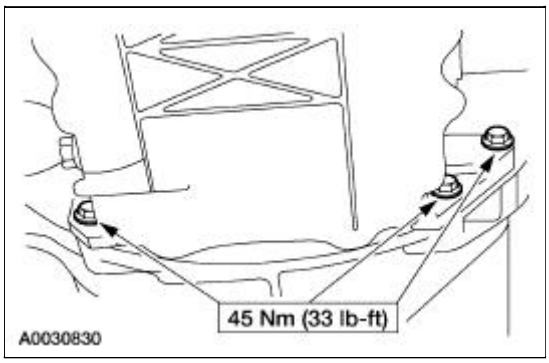
2. Position the oil pan and start the bolts.



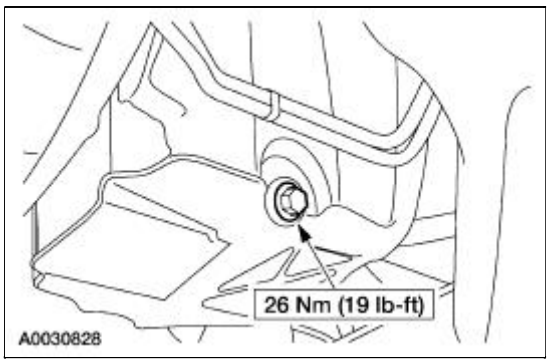
3. Tighten the bolts in two stages in the sequence shown.
    - Stage 1: Tighten to 5 Nm (44 lb-in).
    - Stage 2: Tighten to 10 Nm (89 lb-in).



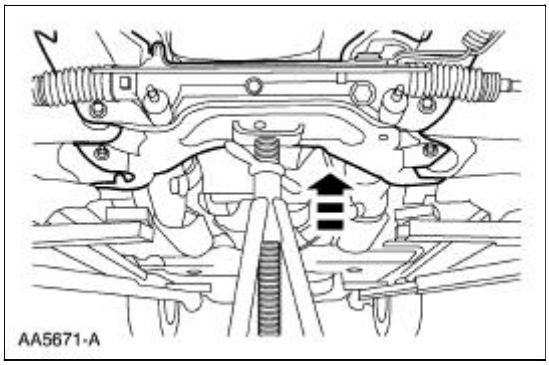
4. Install the transmission lower bolts.



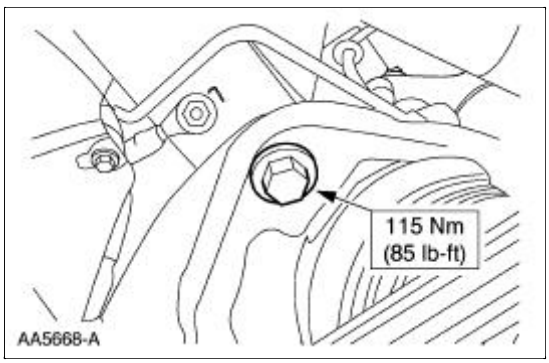
5. Install the oil pan drain plug.



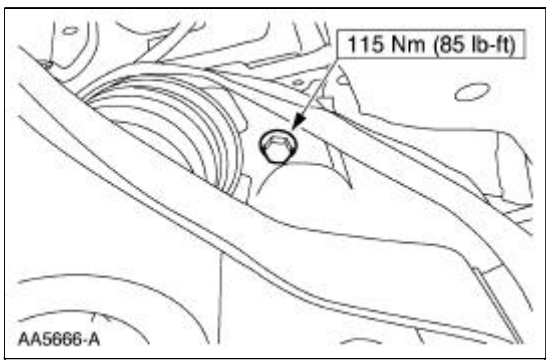
6. Raise the front subframe into position.



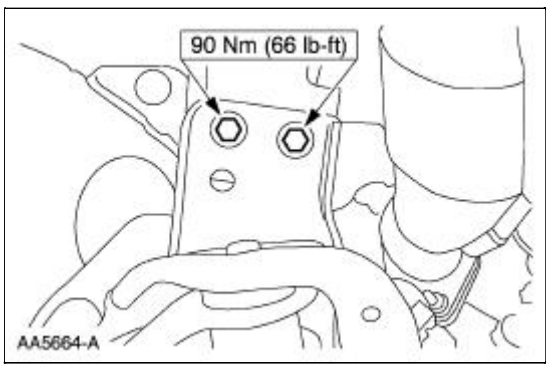
7. Tighten the two bolts.



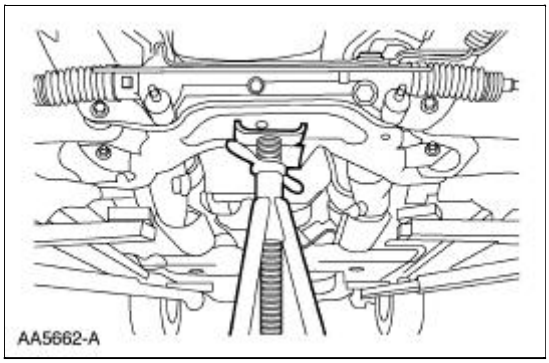
8. Install the two bolts.



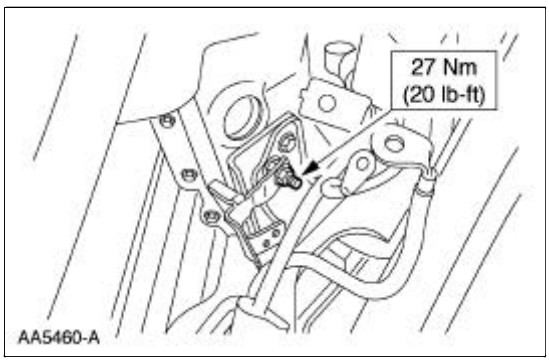
9. Install the four subframe lower bolts.



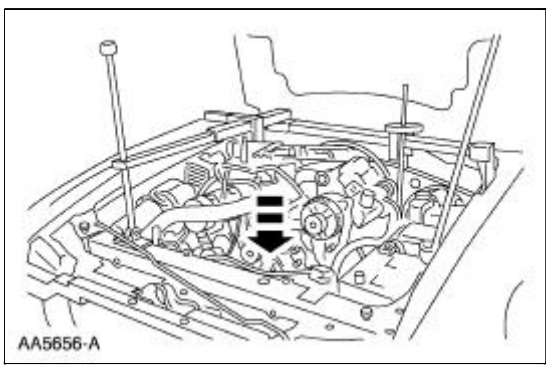
10. Remove the safety stand.



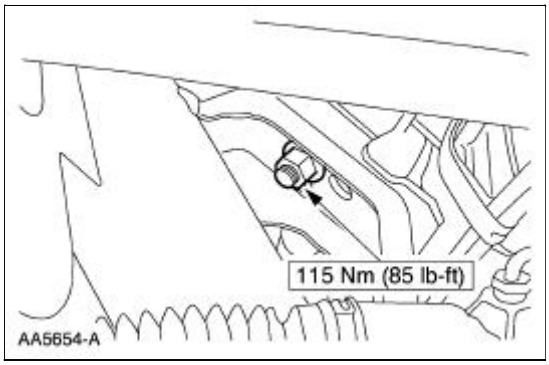
11. Install the bracket.



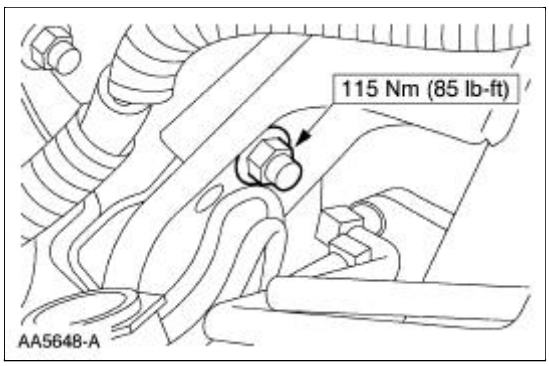
12. Install the starter motor. For additional information, refer to Section 303-06 .
13. Lower the vehicle.
14. Lower the engine.



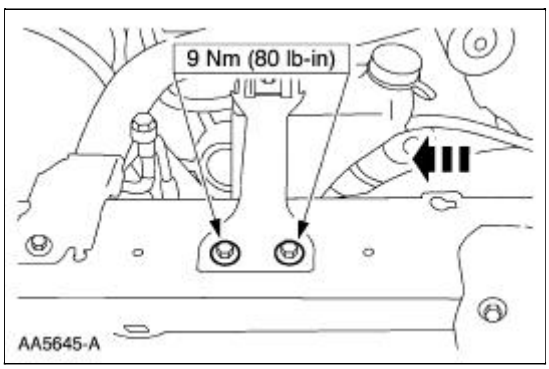
15. Raise and support the vehicle. For additional information, refer to Section 100-02 .
16. Install the RH engine mount nut.



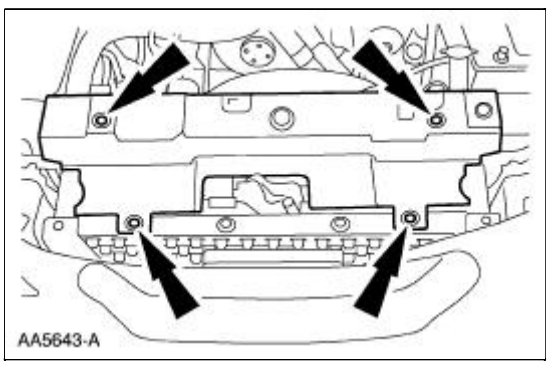
17. Install the LH engine mount nut.



18. Lower the vehicle.
19. Remove the special tools.
20. Install the coolant recovery reservoir.



21. Install the radiator sight shield.



22. Install the air cleaner outlet pipe. For additional information, refer to Section 303-12 .

23. Connect the battery ground cable. For additional information, refer to Section 414-01 .

24. Fill the engine with clean engine oil.

25. **CAUTION: Correct coolant bleeding is critical for correct engine cooling.**

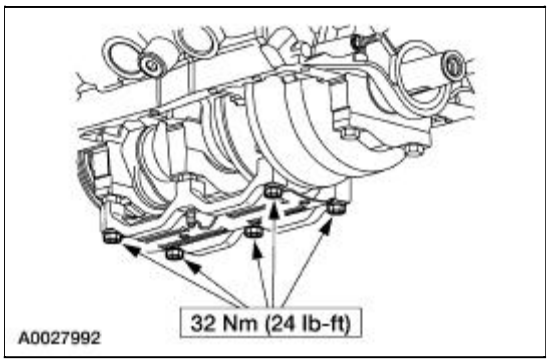
    Fill and bleed the engine cooling system. For additional information, refer to Section 303-03A .

Oil Pan Baffle

Removal and Installation

1. Remove the oil pump screen cover and tube (6622). For additional information, refer to Oil Pump Screen and Pickup Tube in this section.

2. Remove the oil pan baffle (6687).
   - Remove the nuts.

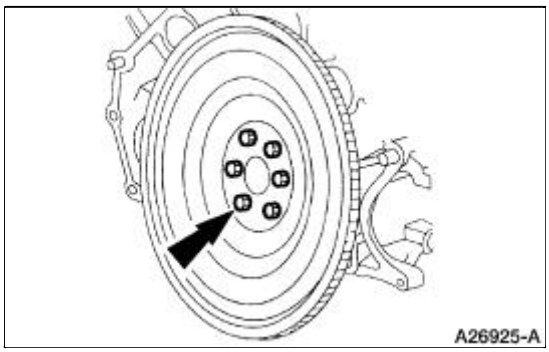


3. To install, reverse the removal procedure.

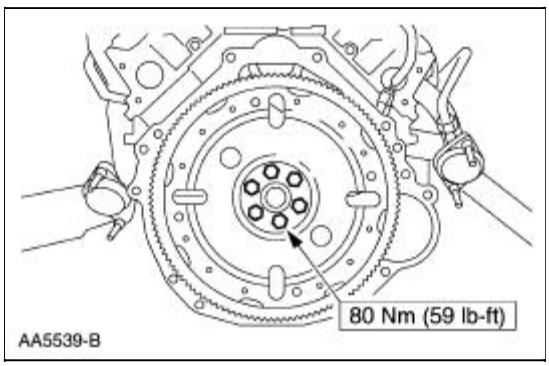
Flywheel

Removal and Installation

1. Remove the clutch. For additional information, refer to Section 308-01 .
2. Remove the flywheel bolts.



3. To install, reverse the removal procedure.

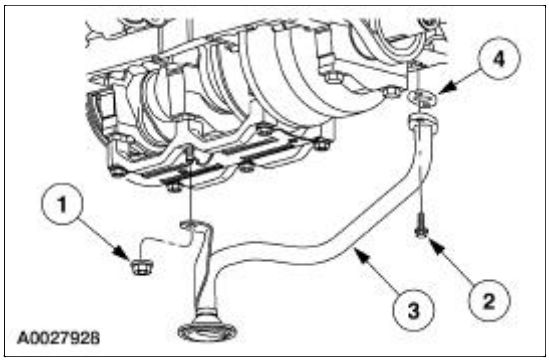


Oil Pump Screen and Pickup Tube

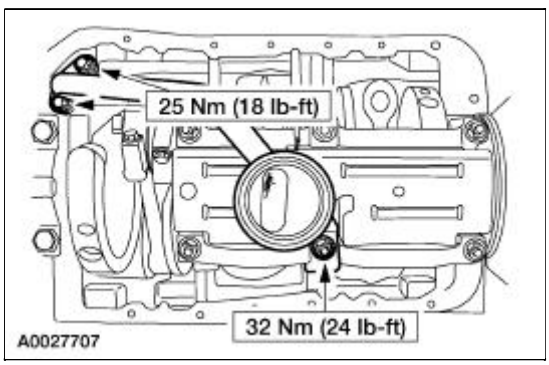
Removal and Installation

1. Remove the oil pan (6675). For additional information, refer to Oil Pan in this section.

2. Remove the oil pump screen cover and tube (6622) and discard the gasket.
    1. Remove the nut.
    2. Remove the two bolts.
    3. Remove the oil pump screen cover and tube.
    4. Remove and discard the gasket.



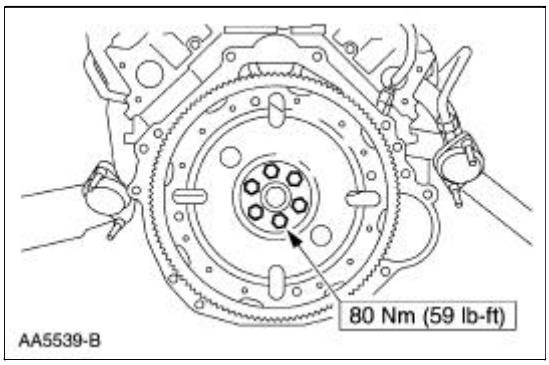
3. To install, reverse the removal procedure.



Flexplate

Removal and Installation

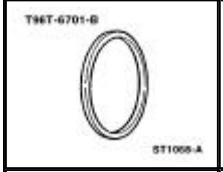
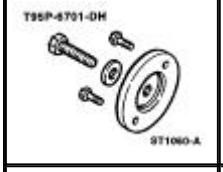
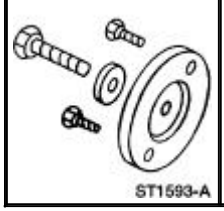
1. Remove the transmission. For additional information, refer to Section 307-01 .
2. Remove the six bolts retaining the flexplate to crankshaft, and remove the flexplate.



3. To install, reverse the removal procedure.

Crankshaft Rear Seal

Special Tool(s)

ST1185-A	Impact Slide Hammer 100-001 (T50T-100-A)
ST1382-A	Remover, Crankshaft Rear Seal 303-519 (T95P-6701-EH)
	Replacer, Rear Crankshaft Seal 303-516 (T95P-6701-BH)
	Spacer, Rear Crank Seal Replacer 303-561 (T96T-6701-B)
	Adapter, Crankshaft Rear Seal (Use only the adapter retaining bolts) 303-518 (T95P-6701-DH)
 ST1593-A	Adapter, Crankshaft Rear Seal (Use only the adapter and the center jack screw) 303-S560 (T96T-6701-A)

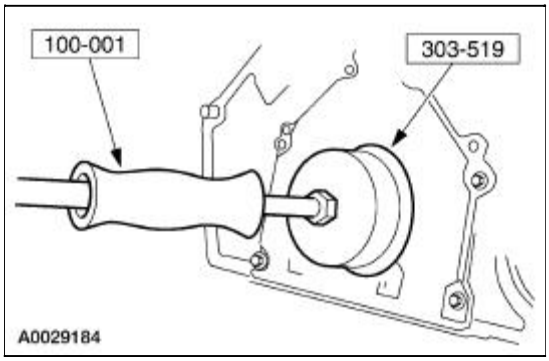
Material

Item	Specification
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Removal

1. Remove the flywheel or the flexplate. For additional information, refer to Flexplate in this section.

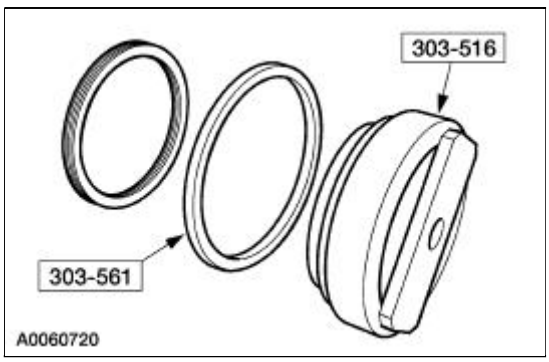
2. Using the special tools, remove the crankshaft rear seal.



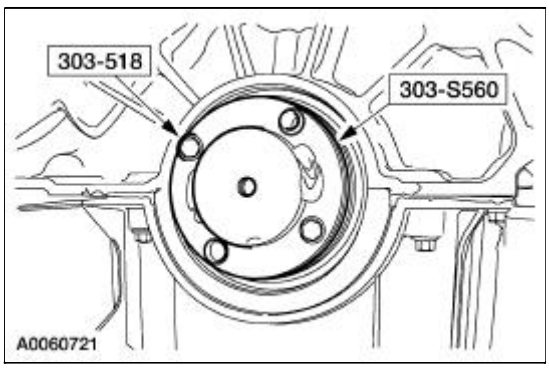
Installation

1. Clean and inspect the mating surface.
2. **NOTE:** Lubricate the crankshaft rear seal lips with clean engine oil prior to installation.

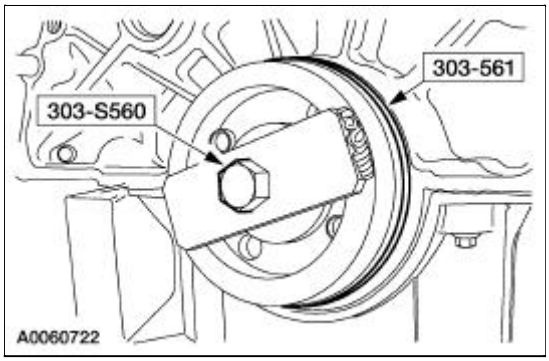
   Assemble the special tools and the crankshaft rear seal.



3. Install the special tools on the rear of the crankshaft.



4. Install the crankshaft rear seal. Tighten the center jack screw (303-S560) until the spacer (303-561) contacts the engine block.



5. Install the flywheel or the flexplate. For additional information, refer to Flexplate in this section.

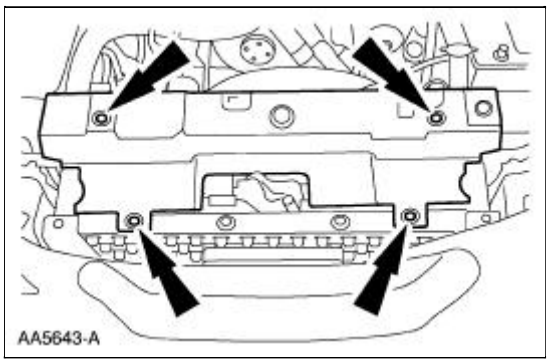
Engine Support Insulators

Special Tool(s)

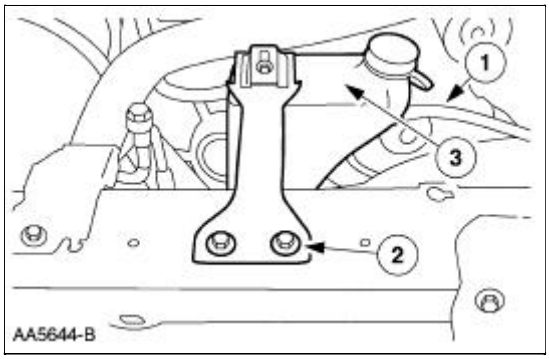
ST2333-A	3 Bar Engine Support Kit 303-F072
ST2375-A	Engine Lift Bracket Set 303-D095 (D94L-6001-A) or equivalent

Removal

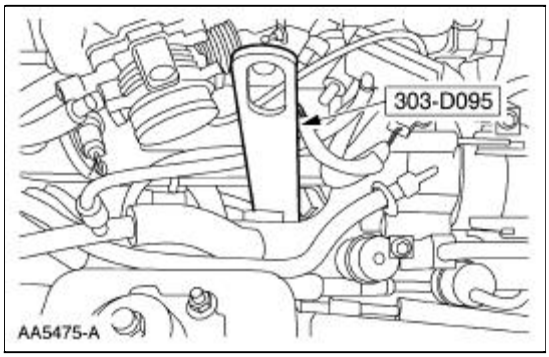
1. Disconnect the battery ground cable (14301). For additional information, refer to Section 414-01 .
2. Remove the air cleaner outlet tube (9B659). For additional information, refer to Section 303-12 .
3. Remove the radiator sight shield (8C291).



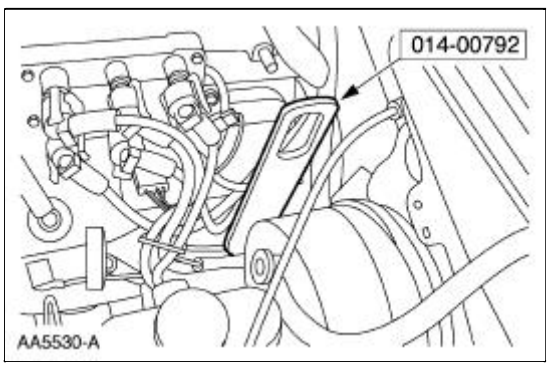
4. Remove the coolant recovery reservoir (8A080).
    1. Disconnect the hose.
    2. Remove the bolts.
    3. Remove the coolant recovery reservoir.



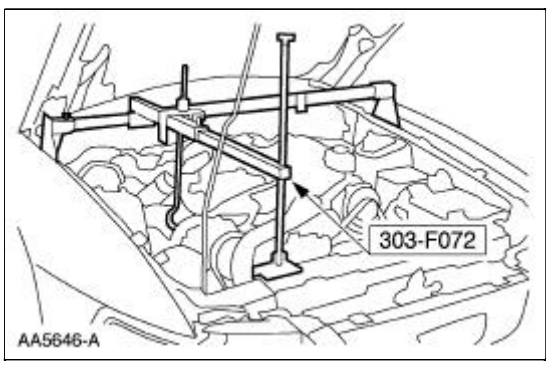
5. Install the special tool.



6. Install the special tool.

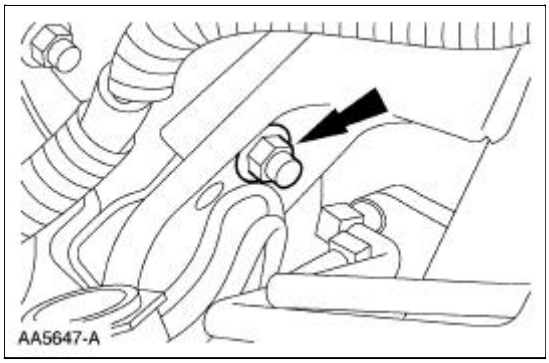


7. Install the special tool.

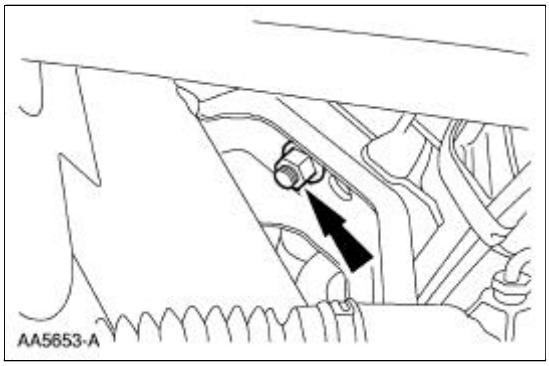


8. Raise the vehicle on a hoist. For additional information, refer to Section 100-02 .

9. Remove the LH engine mount nut.

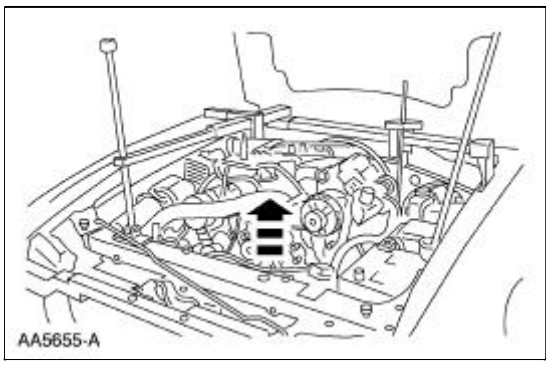


10. Remove the RH engine mount nut.



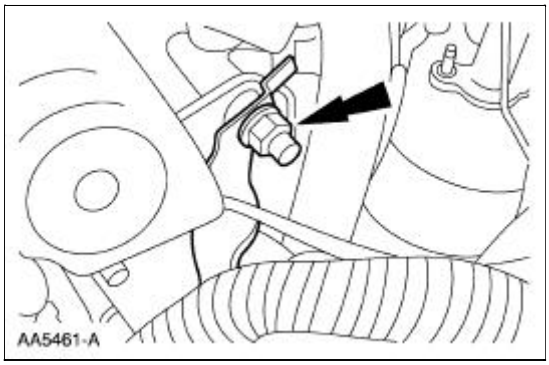
11. Lower the vehicle.

12. Raise the engine.

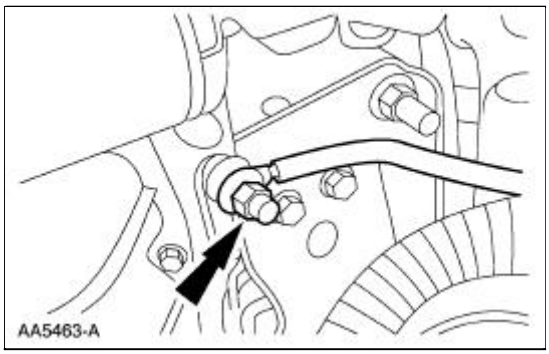


13. Raise the vehicle on a hoist.

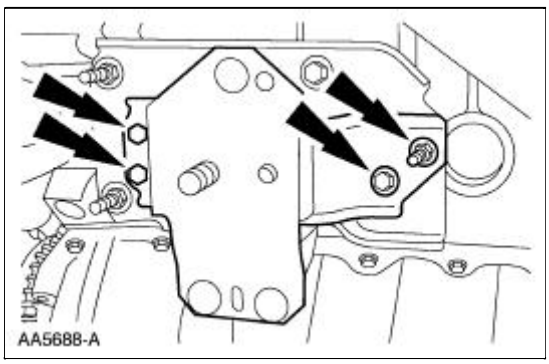
14. Position the bracket aside.
    - Remove the nut.



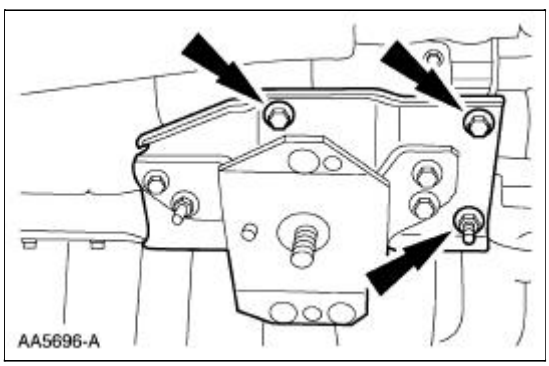
15. Disconnect the engine ground strap.
    - Remove the nut.



16. Remove the LH engine insulator (6038).
    - Remove the bolts.

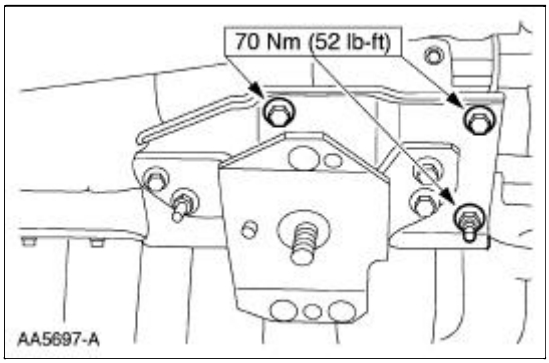


17. Remove the RH engine insulator.
    - Remove the bolts.
    - Remove the nuts.

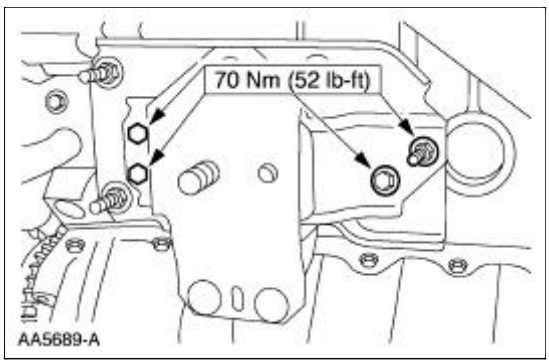


Installation

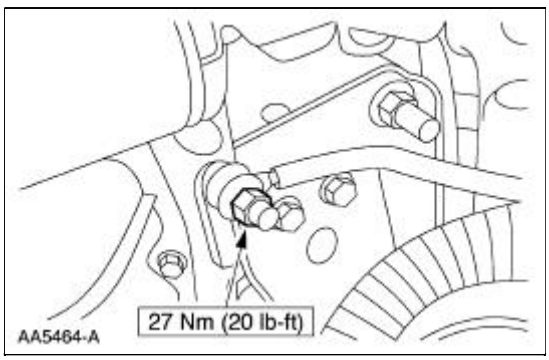
1. Install the RH engine insulator.
    - Install the nuts.
    - Install the bolts.



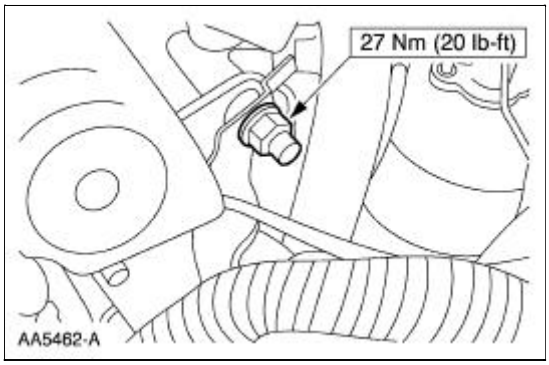
2. Install the LH engine insulator.



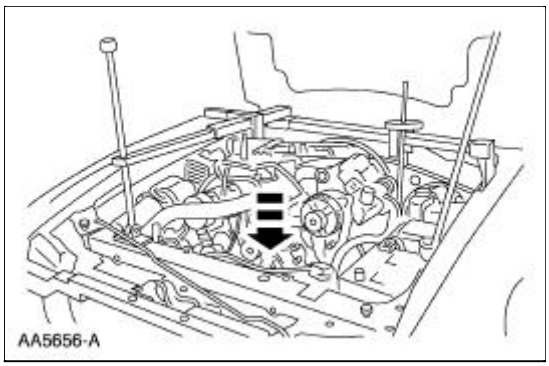
3. Connect the engine ground strap.



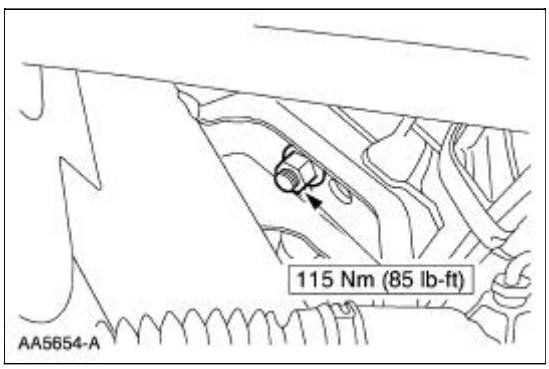
4. Install the bracket.



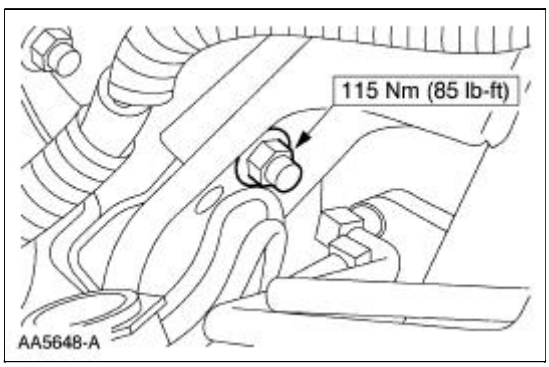
5. Lower the vehicle.
6. Lower the engine.



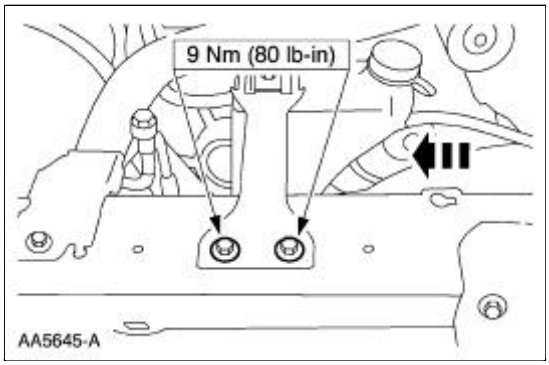
7. Raise the vehicle.
8. Install the RH engine mount nut.



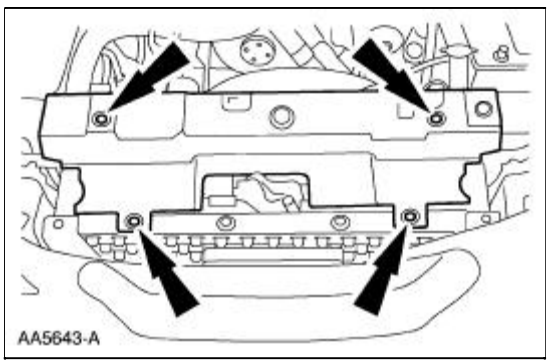
9. Install the LH engine mount nut.



10. Lower the vehicle.
11. Remove the special tools.
12. Install the coolant recovery reservoir.



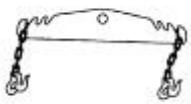
13. Install the radiator sight shield.



14. Install the air cleaner outlet tube. For additional information, refer to Section 303-12 .
15. Connect the battery ground cable. For additional information, refer to Section 414-01 .

Engine

Special Tool(s)

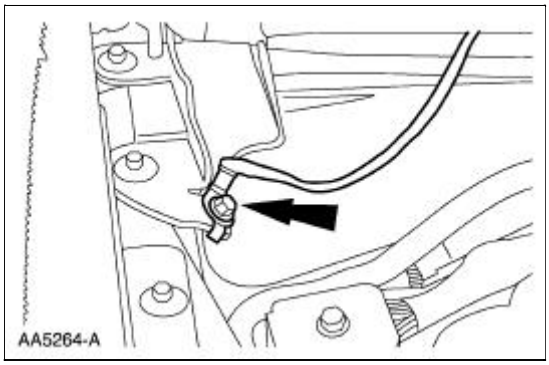
ST2375-A	Lifting Bracket Set, Engine 303-D095 (D94L-6001-A) or equivalent
 ST1602-A	Spreader Bar 303-D089 (D93P-6001-A3) or equivalent
ST1341-A	Heavy Duty Floor Crane 014-00071 or equivalent

Removal

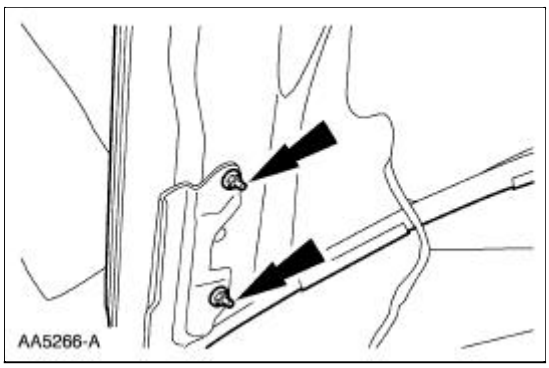
WARNING: Do not smoke or carry lighted tobacco or open flame of any type when working on or near any fuel related components. Highly flammable mixtures are always present and may be ignited, resulting in possible personal injury.

All vehicles

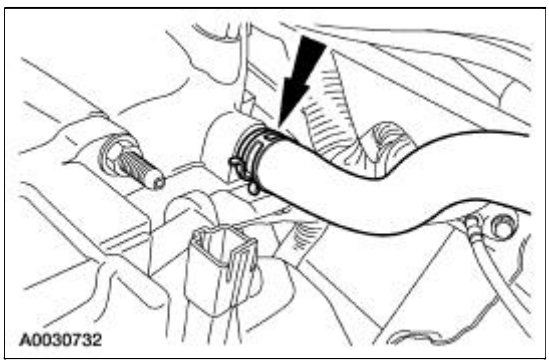
1. Drain the engine cooling system. For additional information, refer to Section 303-03A .
2. Recover the A/C refrigerant. For additional information, refer to Section 412-00 .
3. Disconnect the battery negative cable (14301). For additional information, refer to Section 414-01 .
4. Relieve the fuel pressure. For additional information, refer to Section 310-00 .
5. Disconnect the hood ground strap.



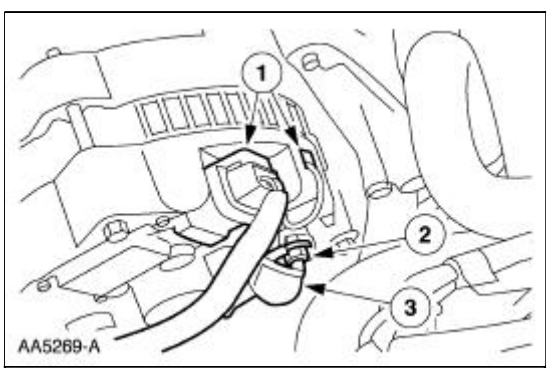
6. Remove the hood (16612).



7. Disconnect the vacuum hose.

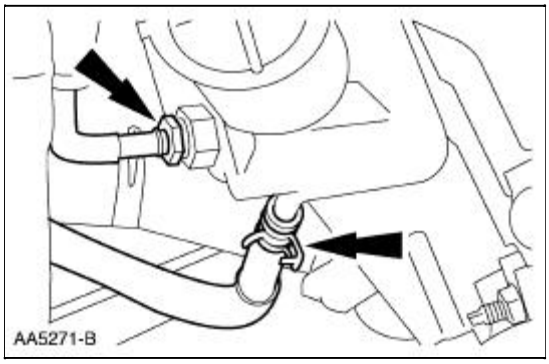


8. Disconnect the generator (10346).
    1. Disconnect the connectors.
    2. Remove the nut.
    3. Remove the battery positive cable.

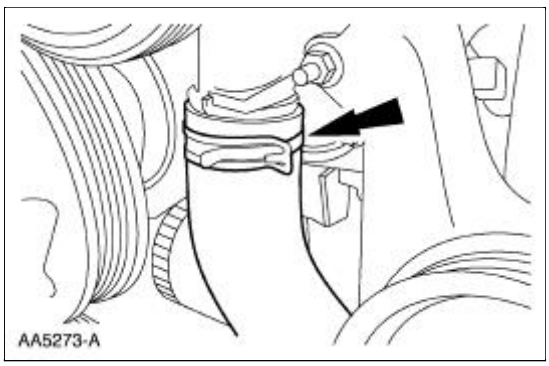


9. **NOTE:** Place a suitable container under the pump.

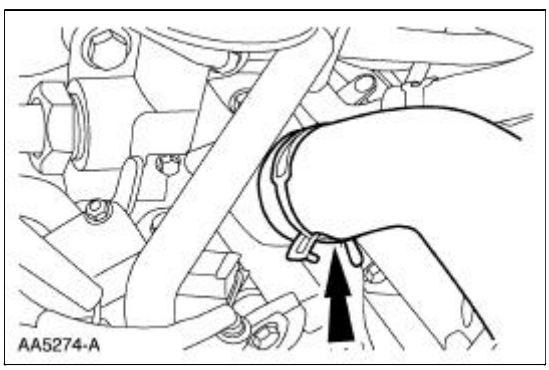
Disconnect the power steering pump (3A674).



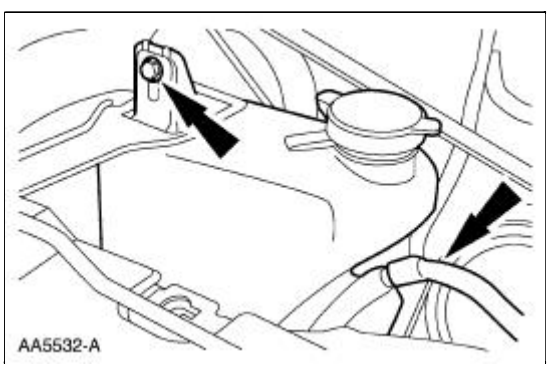
10. Disconnect the lower radiator hose (8286).



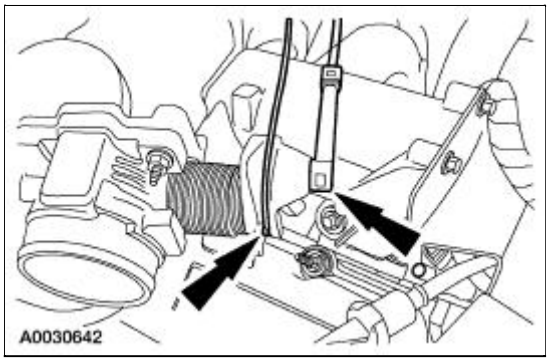
11. Disconnect the upper radiator hose (8620).



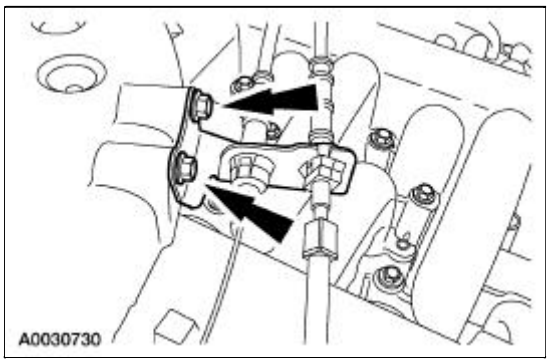
12. Remove the radiator coolant recovery reservoir (8A080).



13. Disconnect the accelerator cable and, if equipped, the speed control cable.



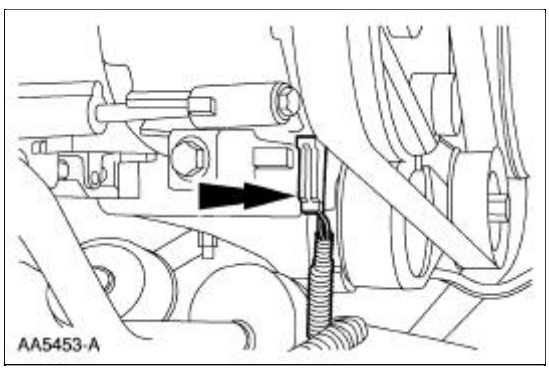
14. Position the accelerator cable bracket (9723) aside.
    - Remove the bolts.



15. Remove the air cleaner outlet tube (9B659) and the air cleaner assembly. For additional information, refer to Section 303-12 .

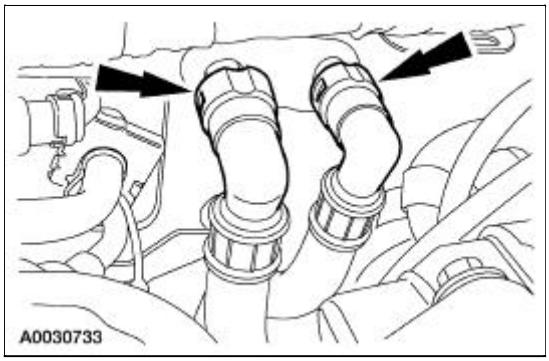
16. Disconnect the A/C manifold and tube (19D734). For additional information, refer to Section 412-03 .

17. Disconnect the A/C compressor electrical connector.

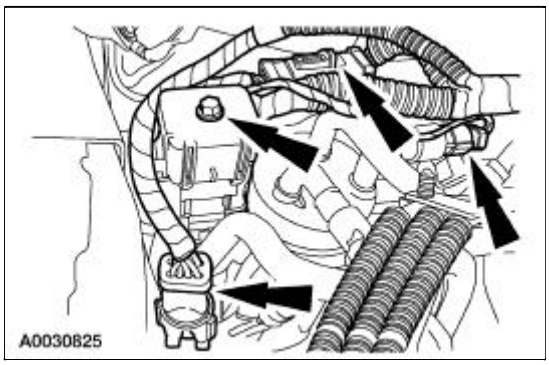


18. Disconnect the fuel supply line (9J337). For additional information, refer to Section 310-00 .

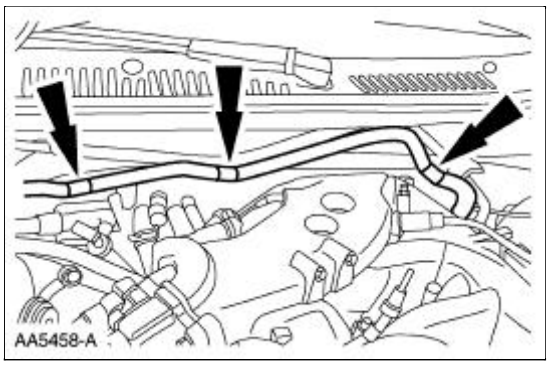
19. Disconnect the heater hoses (12270).



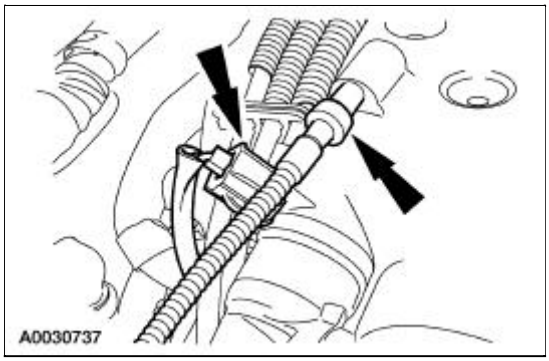
20. Disconnect the following connectors:
    - 42-pin electrical connector
    - 16-pin electrical connector
    - 8-pin electrical connector
    - A/C pressure switch



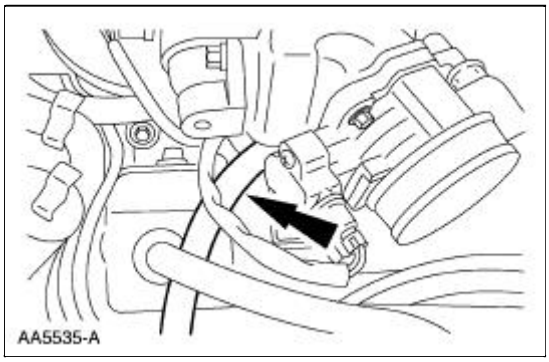
21. Position the wire harness aside.



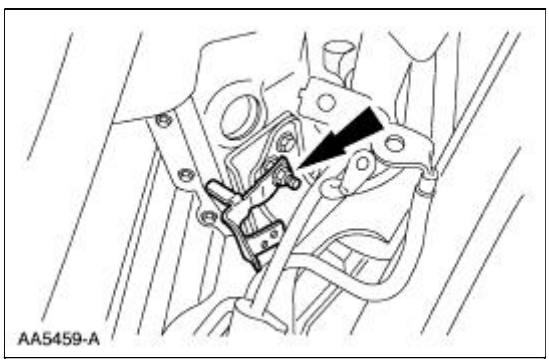
22. Disconnect the connector and the vacuum tube.



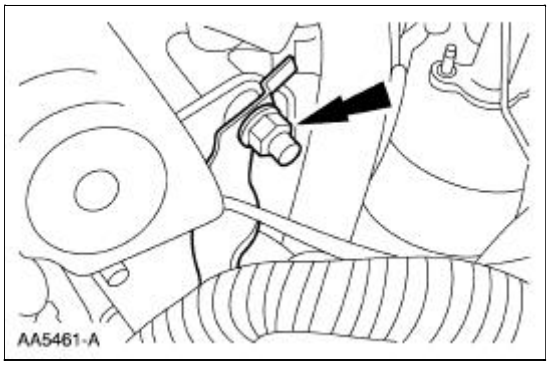
23. Disconnect the evaporative emissions (EVAP) return tube (9G271).



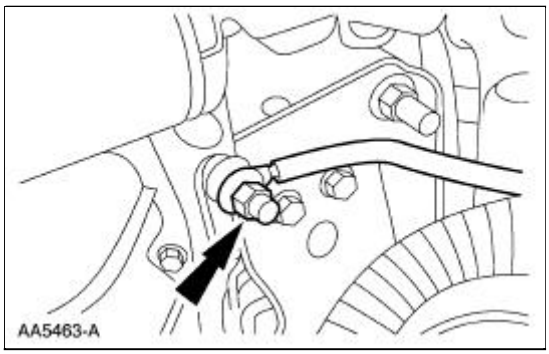
24. Raise the vehicle on a hoist. For additional information, refer to Section 100-02 .
25. Remove the starter motor (11002). For additional information, refer to Section 303-06 .
26. Remove the dual converter Y-pipe (5F250). For additional information, refer to Section 309-00 .
27. Remove the bracket.



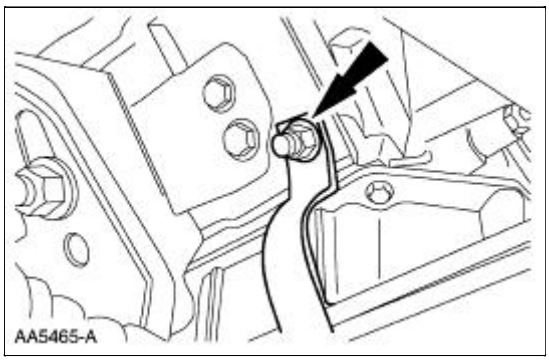
28. Remove the bracket.
    - Remove the nut.



29. Disconnect the engine ground strap.
    - Remove the nut.



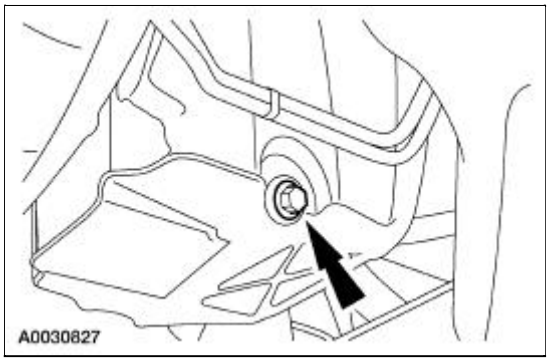
30. Remove the bracket.



Vehicles equipped with manual transmission

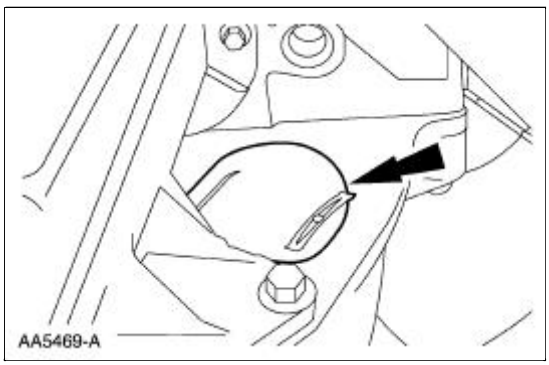
31. Remove the transmission. For additional information refer to Section 308-03A .

32. Drain the engine oil.
    - Remove the oil drain plug.



Vehicle equipped with automatic transmission

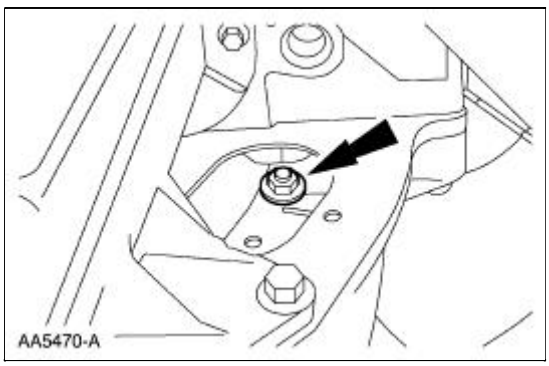
33. Remove the access cover.



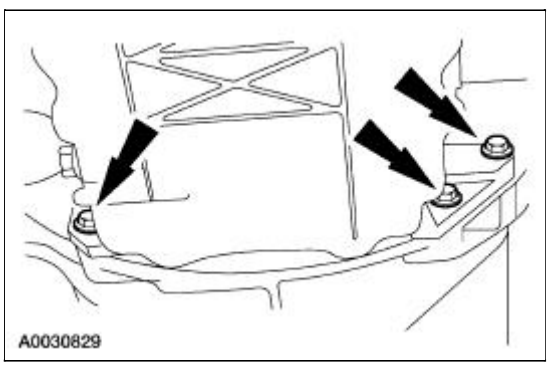
34. **NOTE:** Discard the torque converter nuts.

    Disconnect the torque converter (7902).

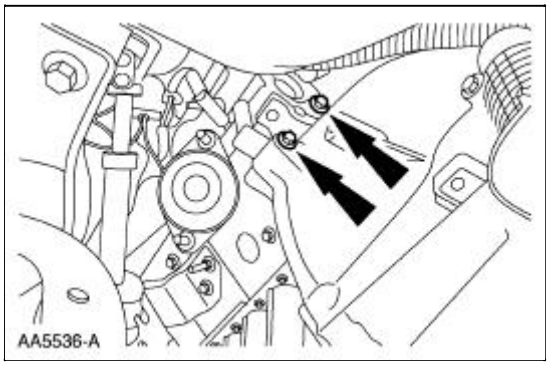
    - Remove the four nuts.



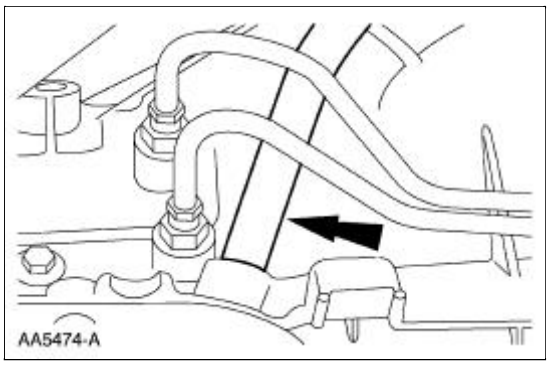
35. Remove the oil pan-to-transmission bolts.



36. Remove the upper bell housing bolts.

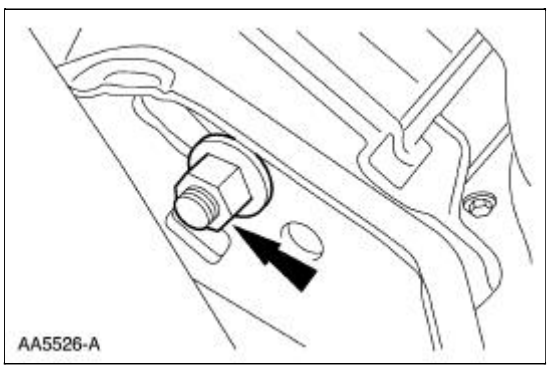


37. Remove the transmission oil filler tube (7A228).

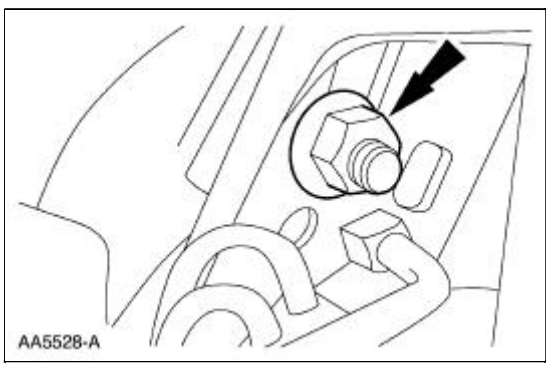


All vehicles

38. Remove the RH engine mount nut.



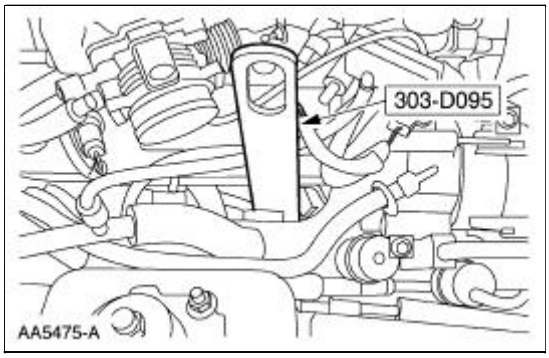
39. Remove the LH engine mount nut.



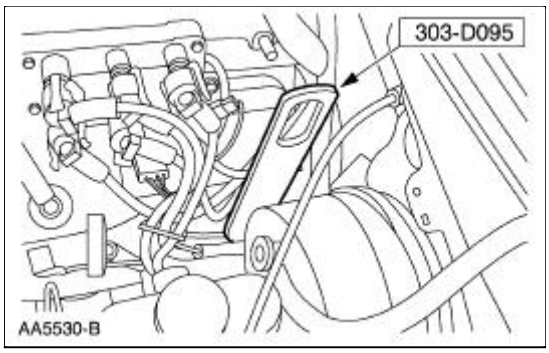
40. Lower the vehicle.

41. Support the transmission.

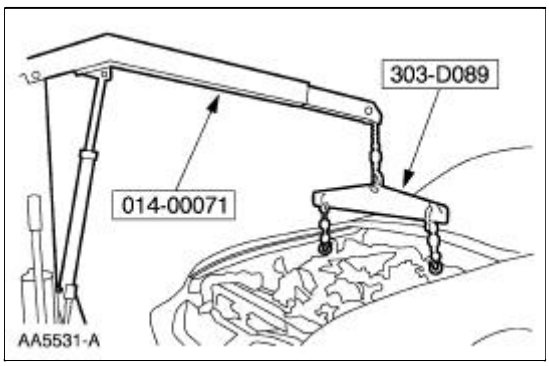
42. Install the special tool.



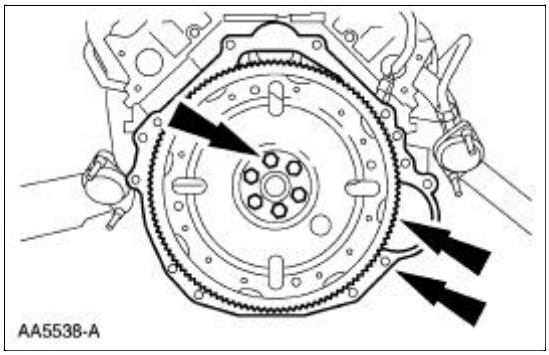
43. Install the special tools.



44. Using the special tool, remove the engine.



45. If necessary, remove the flywheel (6375) and the separator plate (6A372).
    - Remove the bolts.



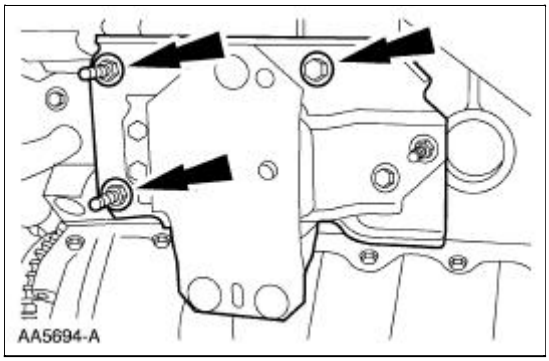
46. Mount the engine on a suitable engine stand.

Engine

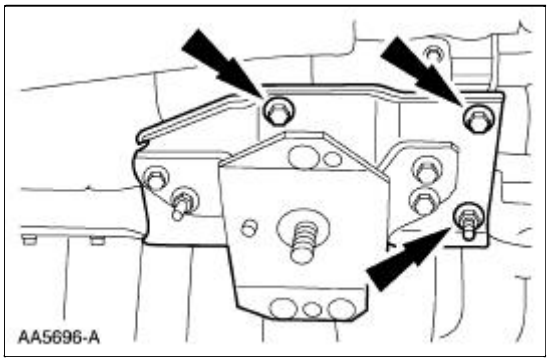
Special Tool(s)

ST1381-A	Service Set, Camshaft 303-017 (T65L-6250-A)
ST1286-A	Remover, Crankshaft Vibration Damper 303-009 (T58P-6316-D)
ST2375-A	Lifting Bracket Set, Engine 303-D095 (D94L-6001-A) or equivalent
	Remover, Power Steering Pump Pulley 211-016 (T69L-10300-B)
ST1385-A	Remover, Oil Seal 303-409 (T92C-6700-CH)
ST1378-A	Remover, Crankshaft Vibration Damper 303-176 (T82L-6316-B)

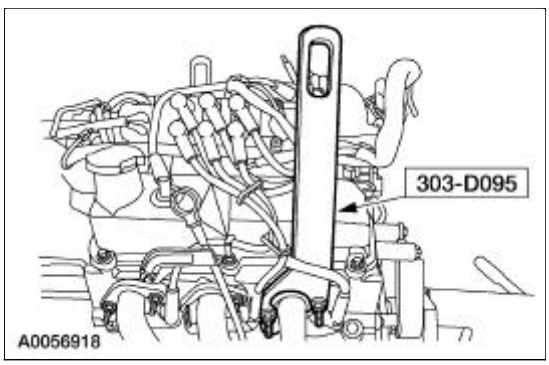
1. Remove the bolts and the LH engine support insulator.



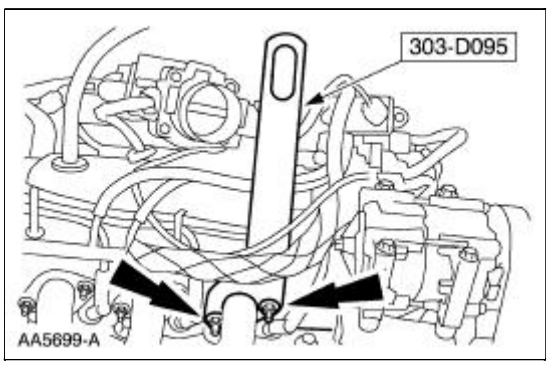
2. Remove the bolts and the RH engine support insulator.



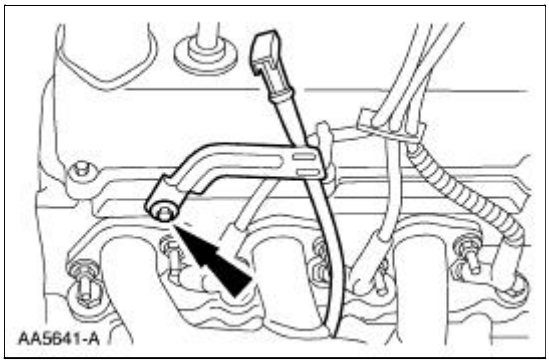
3. Remove the special tool.



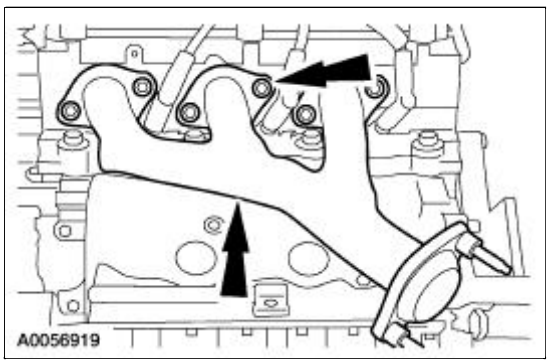
4. Remove the special tool.



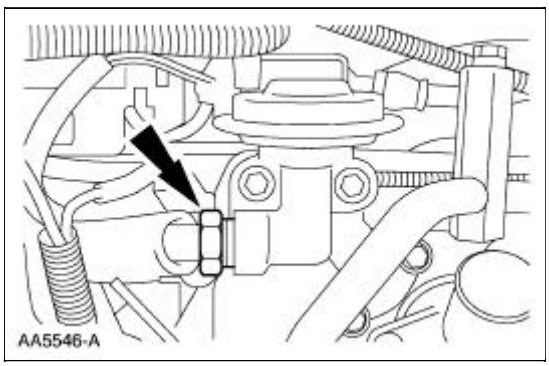
5. Remove the bolt and the oil level indicator and tube. Discard the O-ring.



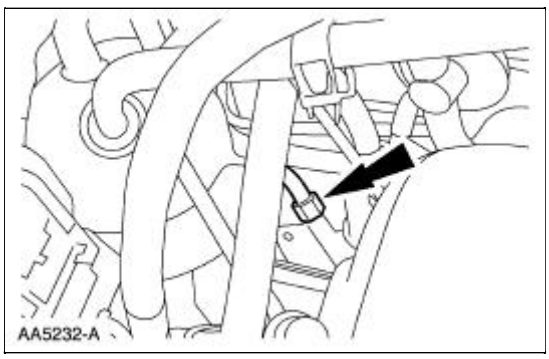
6. Remove the bolts and the LH exhaust manifold. Discard the gasket.



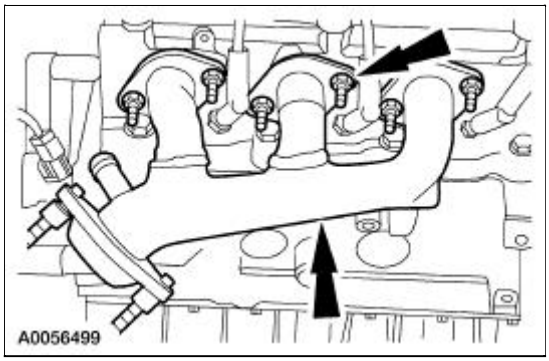
7. Disconnect the exhaust gas recirculation (EGR) tube.



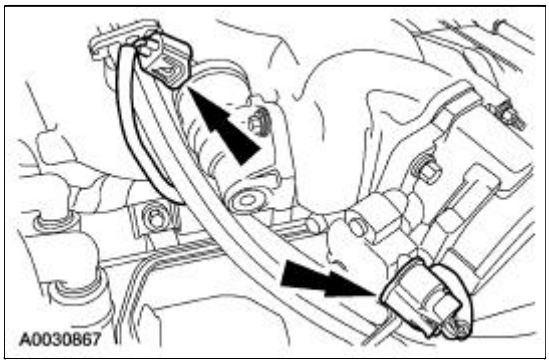
8. Remove the EGR tube.



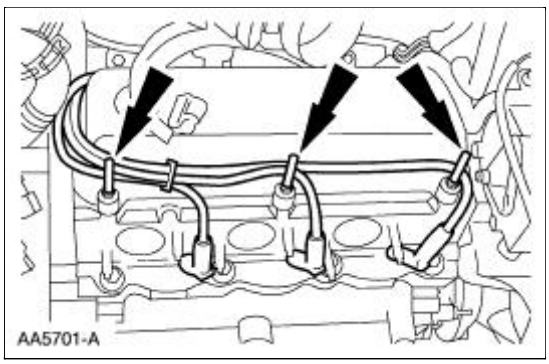
9. Remove the nuts and the RH exhaust manifold. Discard the gasket.



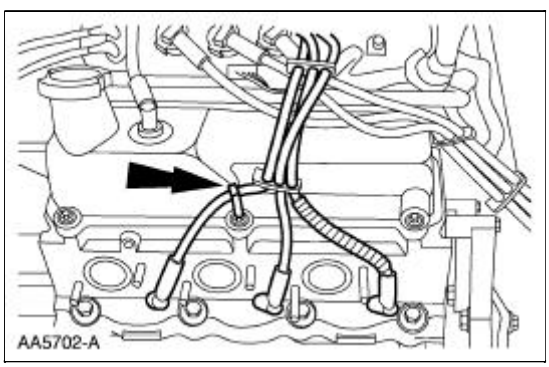
10. Disconnect the idle air control (IAC) valve and throttle position (TP) sensor electrical connectors.



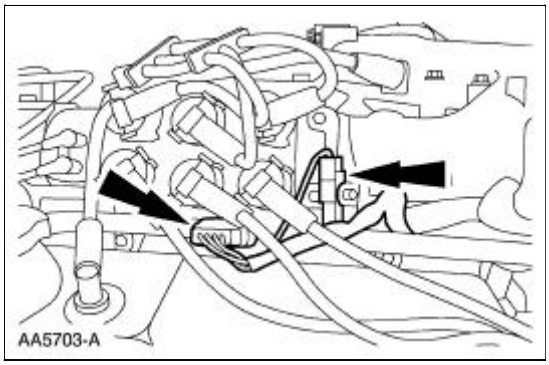
11. Position the RH spark plug wires aside.



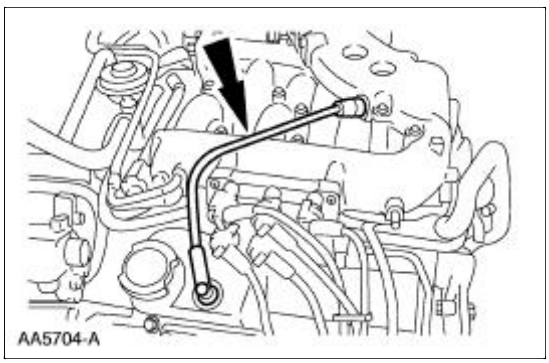
12. Position the LH spark plug wires aside.



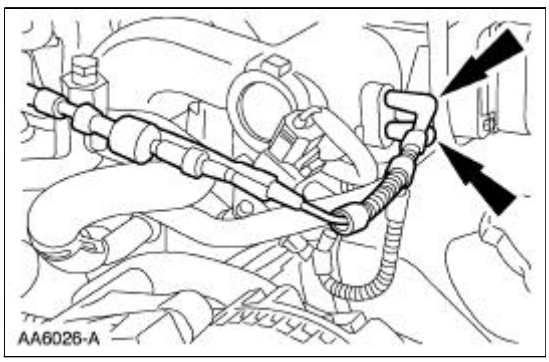
13. Disconnect the ignition coil and the radio interference capacitor electrical connectors.



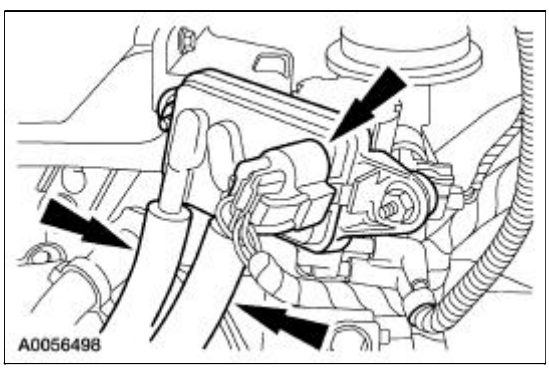
14. Remove the positive crankcase ventilation (PCV) tube.



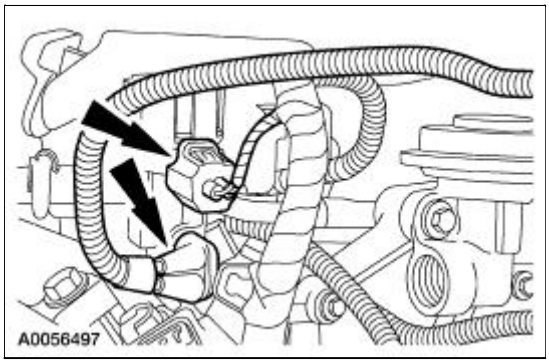
15. Disconnect the vacuum hoses.



16. Disconnect the differential pressure feedback EGR system electrical and vacuum connections.

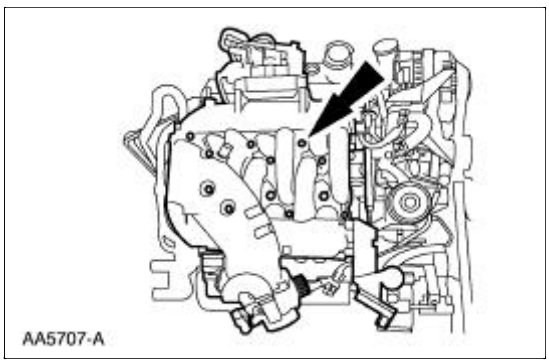


17. Disconnect the EGR vacuum regulator solenoid electrical and vacuum connections.



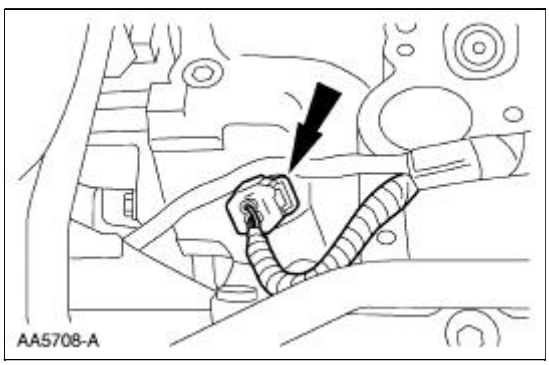
18. **NOTE:** Record the location of the long bolts and the short bolts.

    Remove the upper intake manifold and the upper intake manifold gasket.

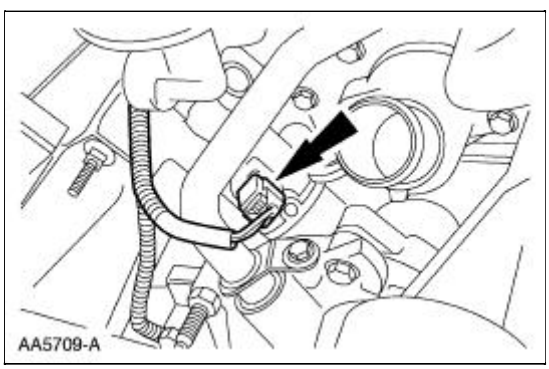


19. Remove the fuel injection supply manifold and the fuel injectors. For additional information, refer to Section 303-04A .

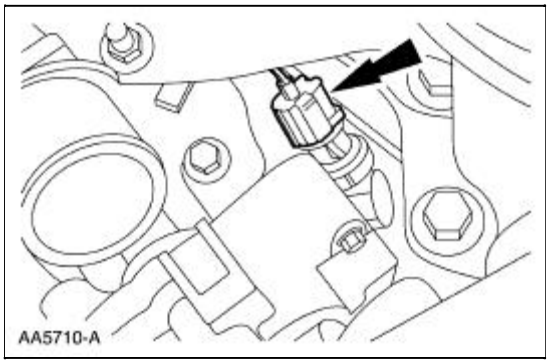
20. Disconnect the cylinder head temperature (CHT) sensor.



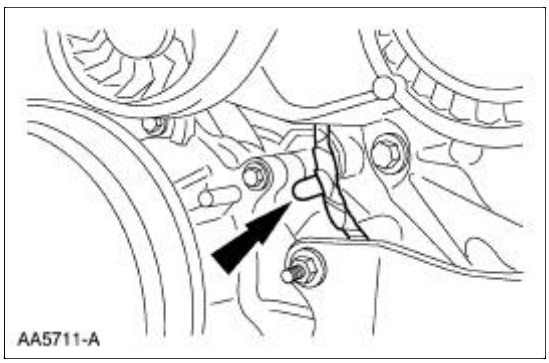
21. Disconnect the camshaft position (CMP) sensor electrical connector.



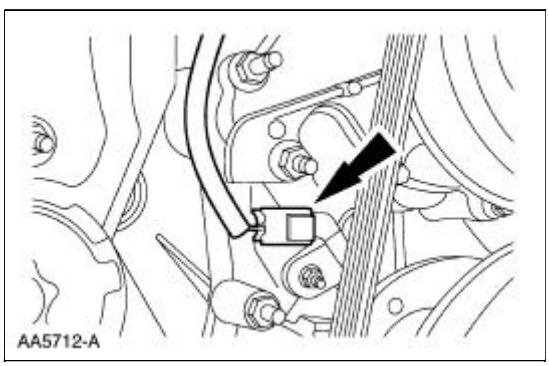
22. Disconnect the engine oil pressure sender electrical connector.



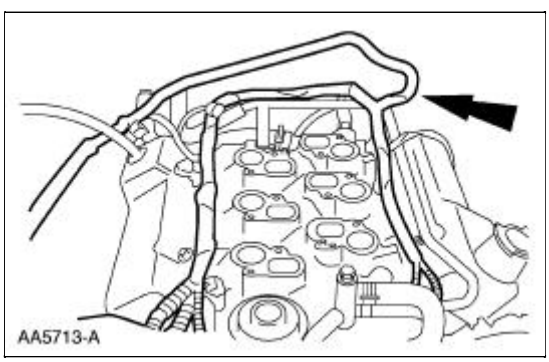
23. Remove the pin-type retainer.



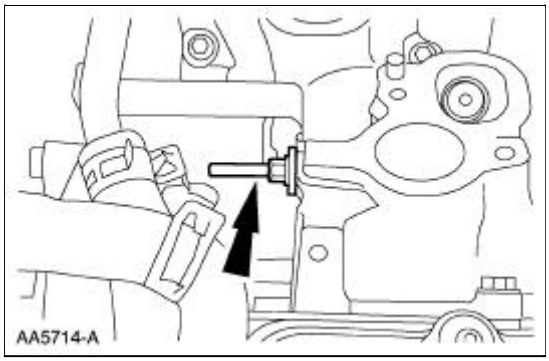
24. Disconnect the crankshaft position (CKP) sensor electrical connector.



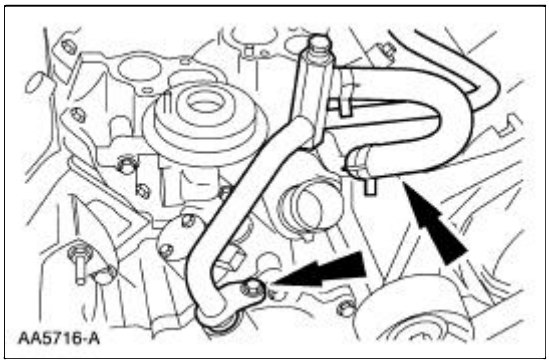
25. Remove the engine wiring harness.



26. Remove the stud bolt.

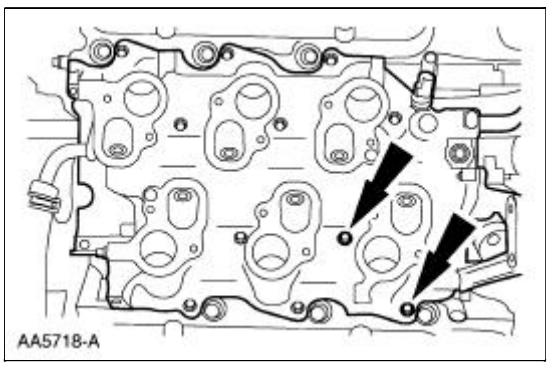


27. Remove the heater water outlet tube.

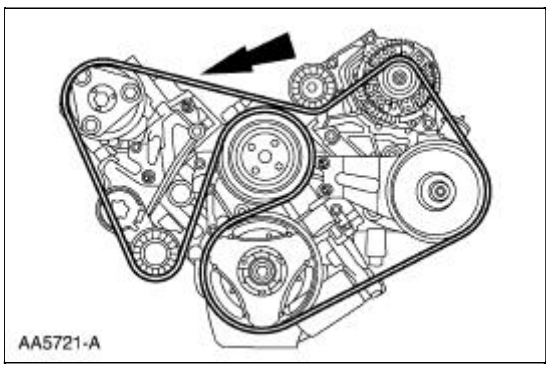


28. **NOTE:** Record the location of the long bolts and the short bolts.

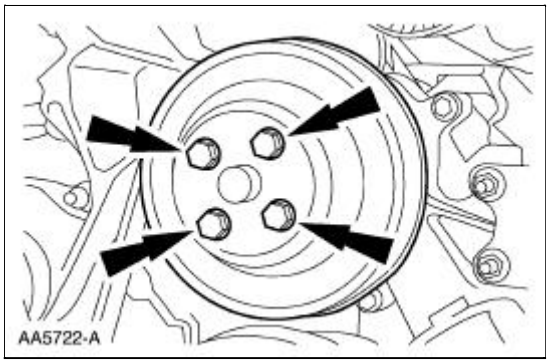
    Remove the lower intake manifold and the intake manifold gasket.



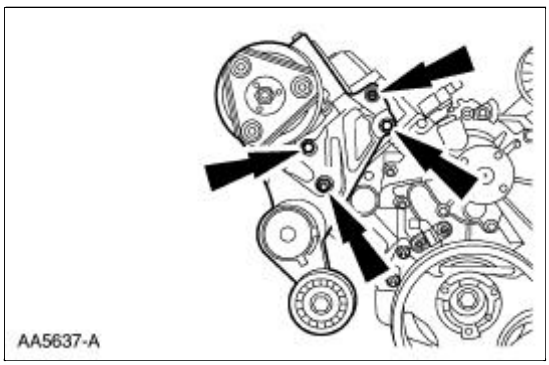
29. Remove the accessory drive belt.



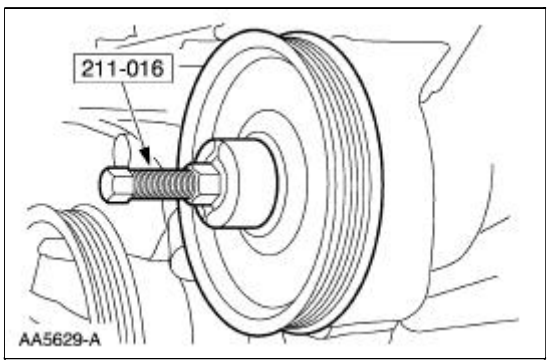
30. Remove the water pump pulley.



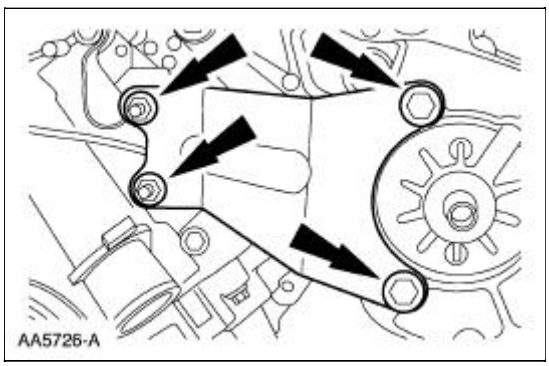
31. Remove the A/C compressor bracket.



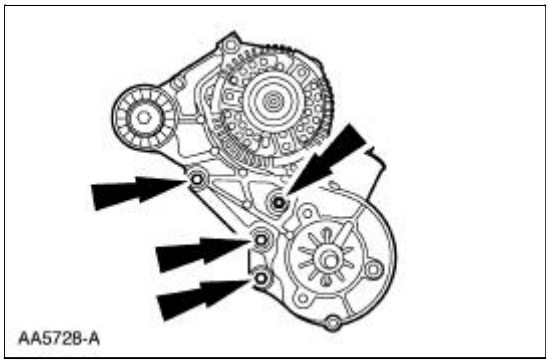
32. Using the special tool, remove the power steering pump pulley.



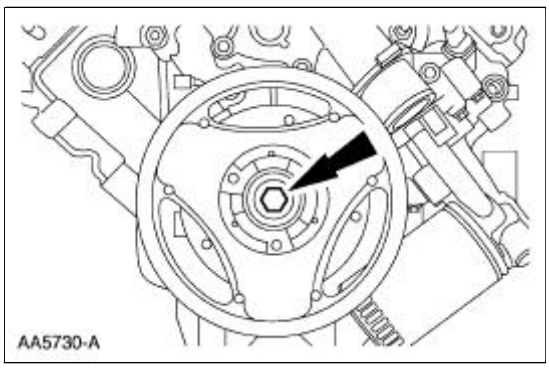
33. Remove the power steering pump bracket.



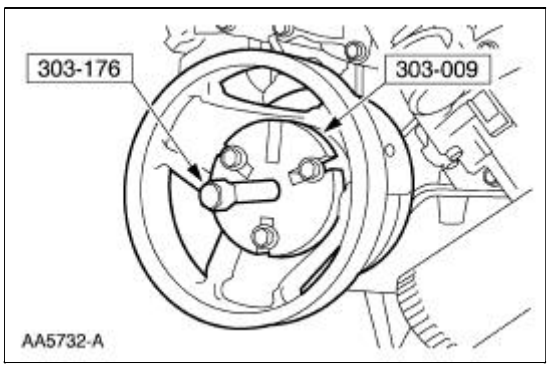
34. Remove the bolts and the generator mounting bracket.



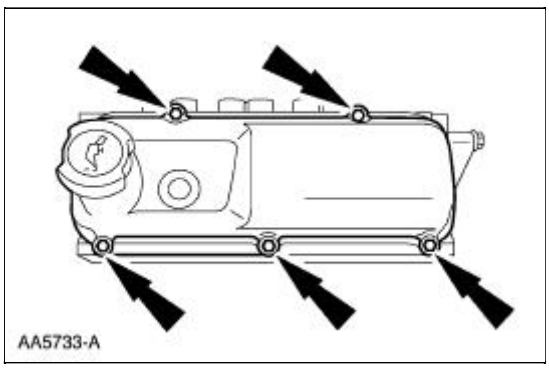
35. Remove the crankshaft pulley bolt.



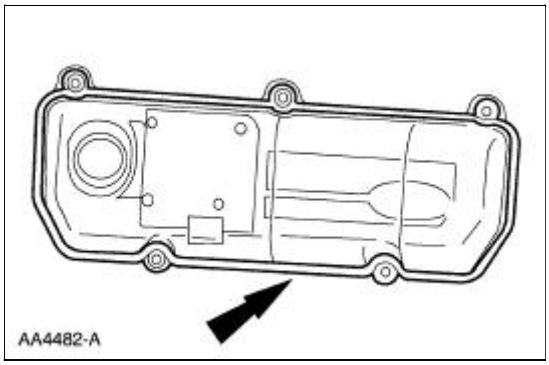
36. Using the special tool, remove the crankshaft pulley.



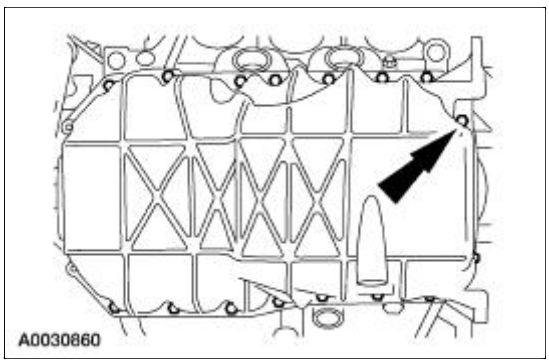
37. Remove the RH and the LH valve covers.



38. Inspect the valve cover gaskets. Install new gaskets if necessary.

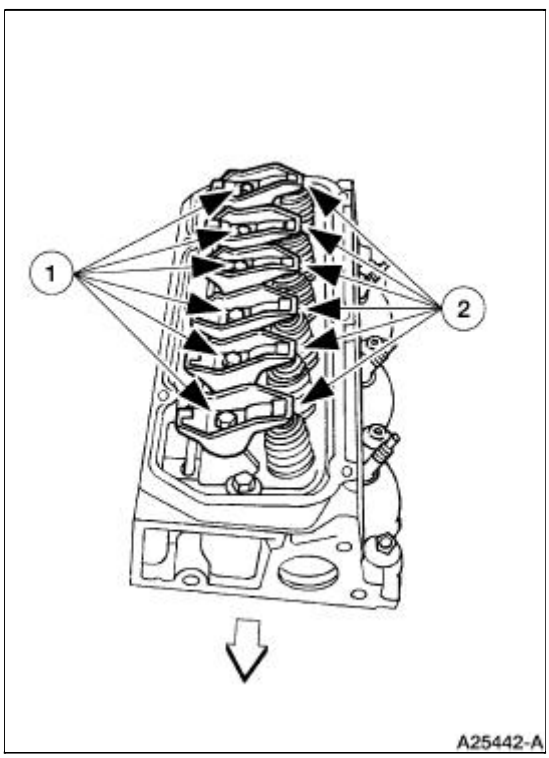


39. Remove the bolts and the oil pan.

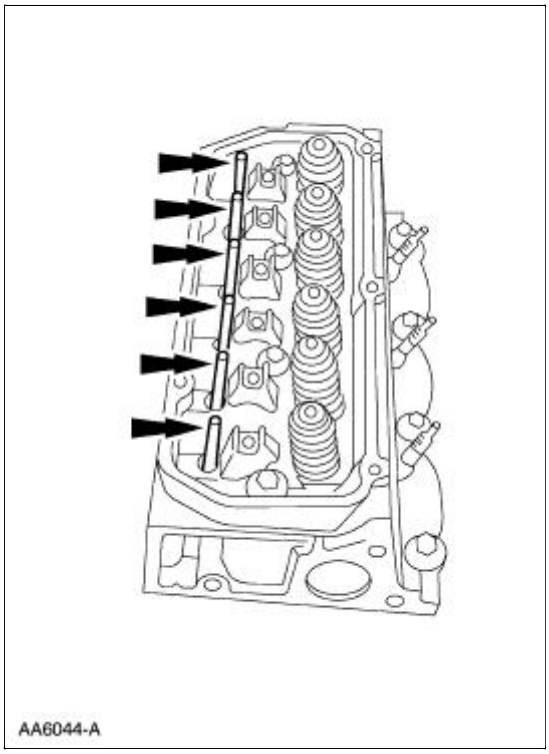


40. **CAUTION: If the components are to be reinstalled, they must be installed into the same position. Mark the components for location.**

Remove the LH rocker arms.
1. Remove the bolts.
2. Remove the rocker arms.

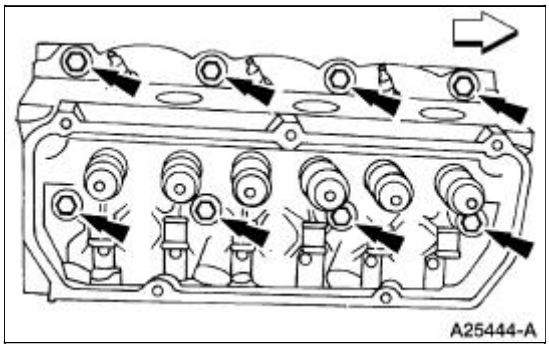


41. Remove the LH push rods.

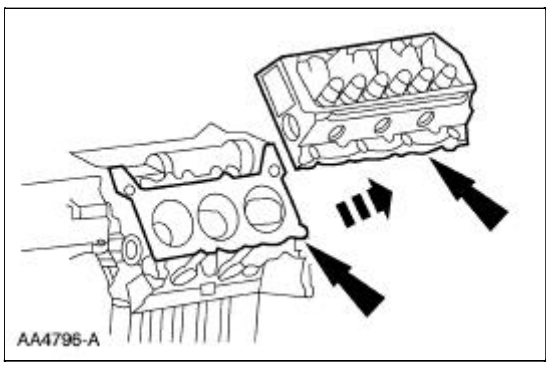


42. **NOTE:** Record the location of the long bolts and the short bolts.

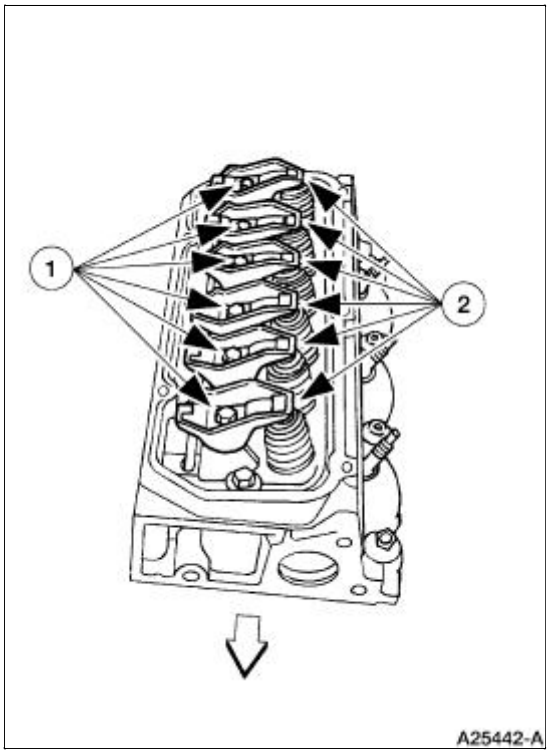
    Remove and discard the LH cylinder head bolts.



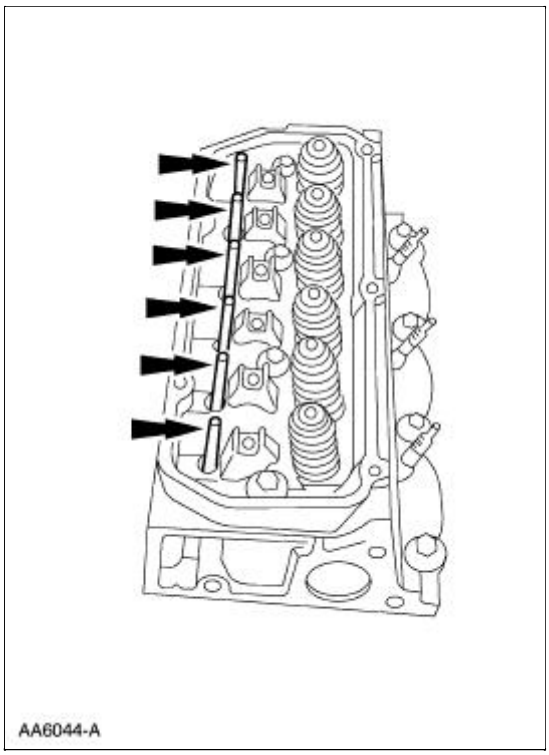
43. Remove the LH cylinder head and gasket. Discard the gasket.



44. Remove the RH rocker arms.
    1. Remove the bolts.
    2. Remove the rocker arms.

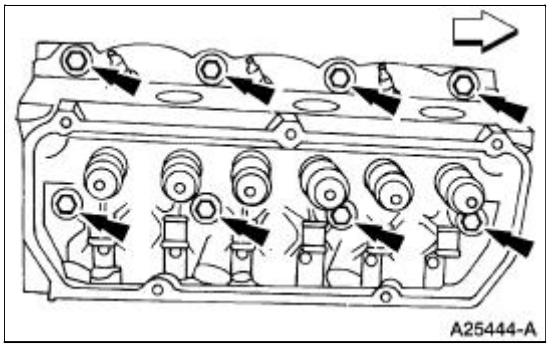


45. Remove the RH push rods.

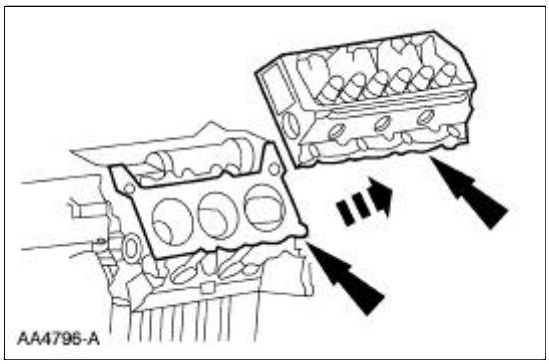


46. **NOTE:** Record the location of the long bolts and the short bolts.

    Remove and discard the RH cylinder head bolts.

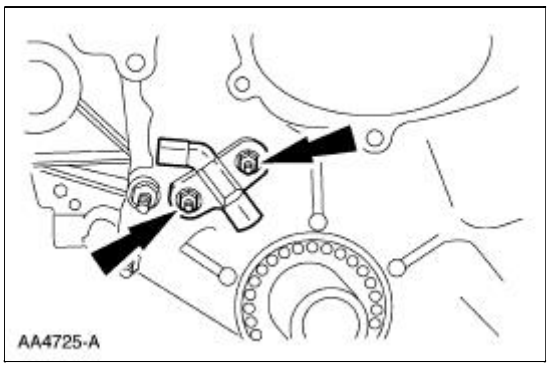


47. Remove the RH cylinder head and gasket. Discard the gasket.

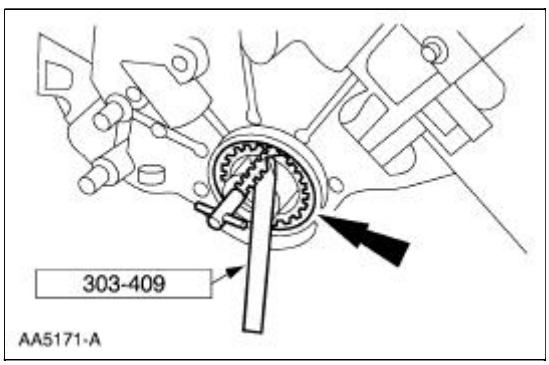


48. Remove the camshaft synchronizer. For additional information, refer to Section 303-14 .

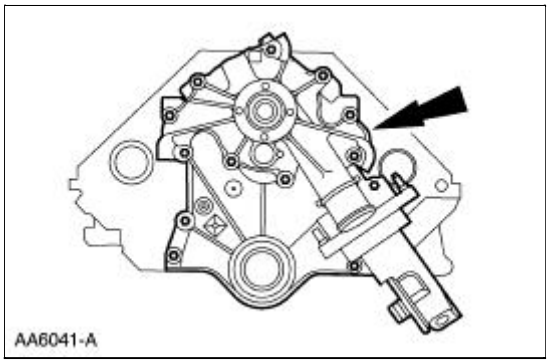
49. Remove the bolts and the crankshaft position sensor.



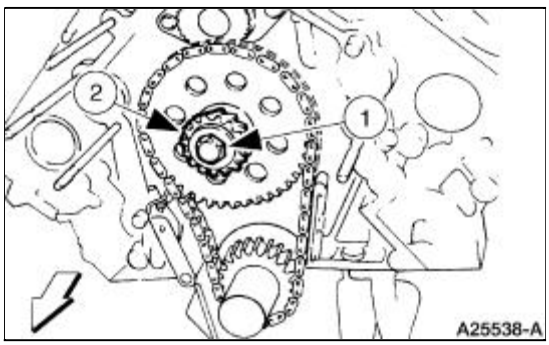
50. Using the special tool, remove the crankshaft front seal.



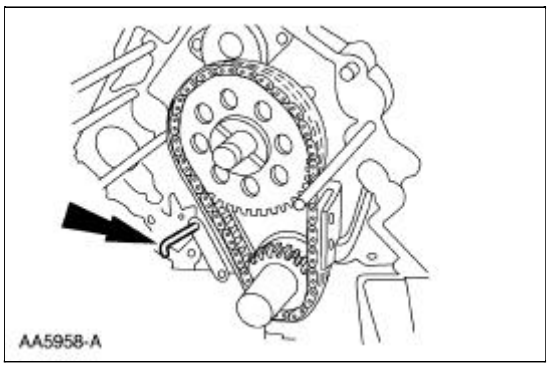
51. Remove the bolts and the front cover assembly and gasket.



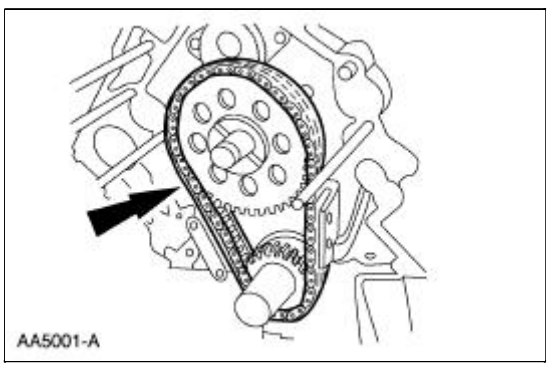
52. Remove the camshaft position sensor drive gear.
    1. Remove the bolt.
    2. Remove the camshaft position sensor drive gear.



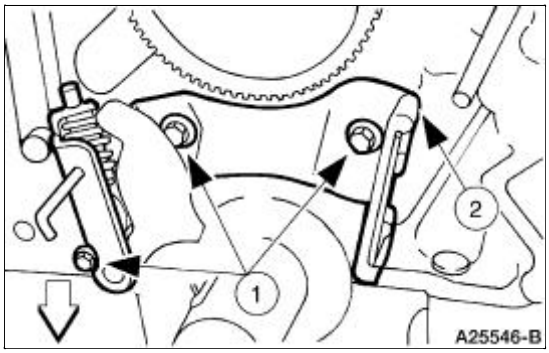
53. Compress and install a retaining pin to hold the timing chain tensioner.



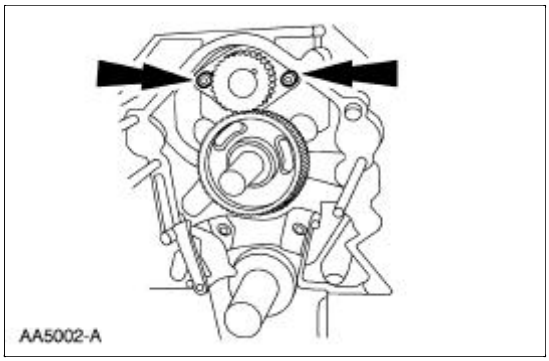
54. Remove the camshaft sprocket, the crankshaft sprocket and the timing chain as an assembly.



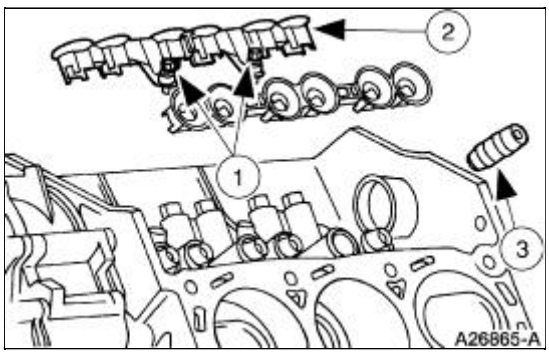
55. Remove the timing chain tensioner.
    1. Remove the bolts.
    2. Remove the timing chain tensioner.



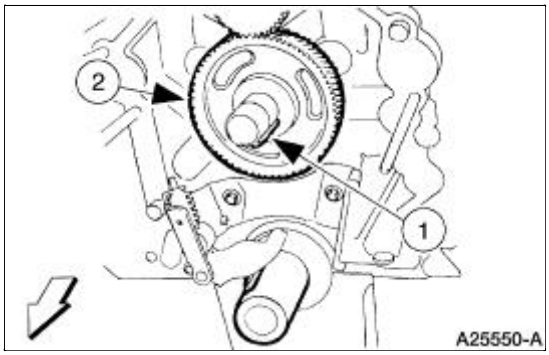
56. Remove the engine dynamic balance shaft.
    - Remove the bolts.
    - Remove the balance shaft driven gear, thrust plate and engine dynamic balance shaft as an assembly.



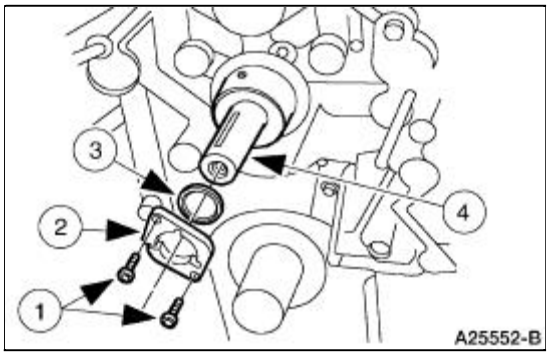
57. Remove the valve tappets.
    1. Remove the bolts.
    2. Remove the tappet guide plates and retainers.
    3. Remove the valve tappets.



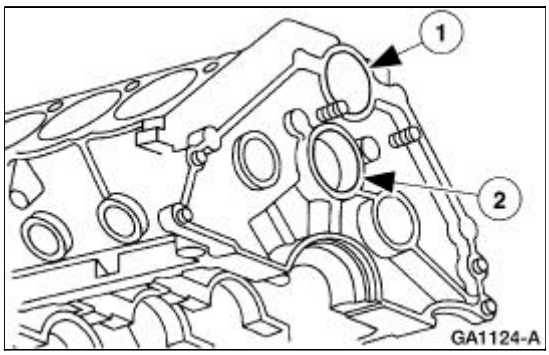
58. Remove the engine balance shaft drive gear.
    1. Remove the camshaft keyway.
    2. Remove the gear.



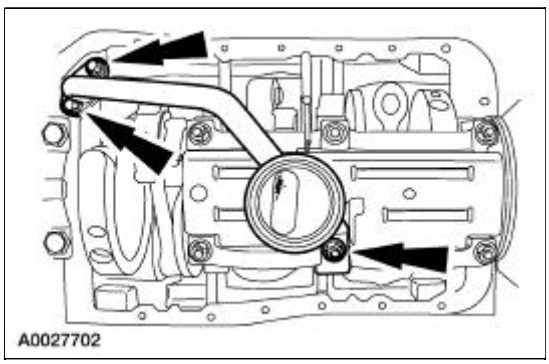
59. Remove the camshaft.
    1. Remove the bolts.
    2. Remove the camshaft thrust plate.
    3. Remove the spacer.
    4. Remove the camshaft.



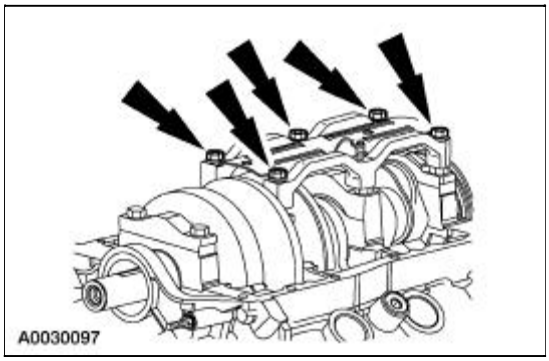
60. Remove the bearing covers.
    1. Remove the engine dynamic balance shaft bearing cover.
    2. Remove the camshaft bearing cover.



61. Remove the oil pump screen cover and tube.



62. Remove the oil pan bridge and baffle assembly.



63. **CAUTION: The connecting rods and bearings are matched to the crankshaft journals. Make sure the components are marked and installed in the correct location.**

CAUTION: Each connecting rod and connecting rod cap are matched sets. They will fit together only one way. Mark them before removing.

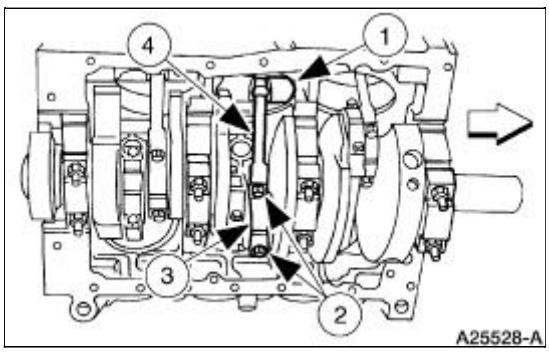
CAUTION: Care should be taken not to damage the connecting rod and the connecting rod cap fractured joint face surface or engine damage may occur.

NOTE: Before removing the pistons, inspect the top of the cylinder bores. If necessary, remove the ridge or carbon deposits from each cylinder, using a cylinder ridge reamer and following the manufacturer's instructions.

Remove the pistons.

1. Make sure the piston being removed is at the bottom of the cylinder bore.
2. Remove the bolts.
3. Remove the connecting rod cap and the lower connecting rod bearing.
4. **CAUTION: Be careful to avoid damage to the cylinder wall when removing the piston.**

   Push the piston and the connecting rod out of the cylinder.



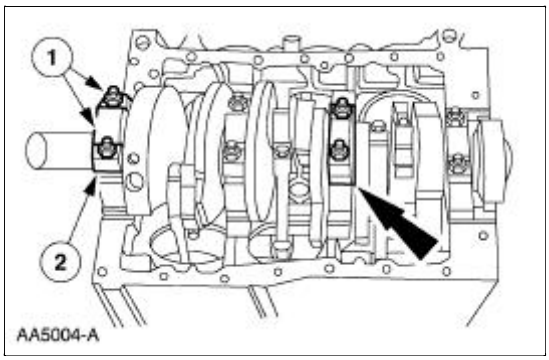
64. Repeat the removal steps for the remaining pistons.

65. **CAUTION: The crankshaft main bearings and the main bearing caps are matched to the crankshaft journals. Make sure the components are marked for position.**

NOTE: The crankshaft main bearing located at the rear main bearing cap is the thrust bearing.

Remove the four main bearing caps and lower crankshaft main bearings.

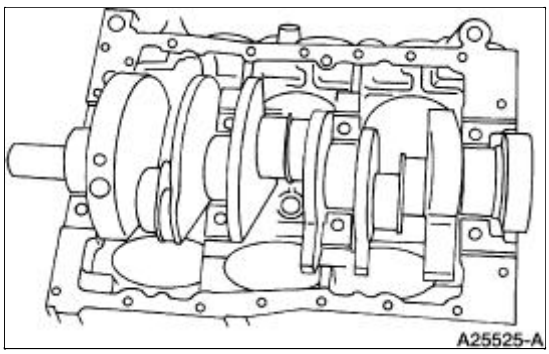
1. Remove the stud bolts.
2. Remove the main bearing cap and the lower crankshaft main bearing.



66. Repeat the main bearing cap and the lower bearing removal steps for the remaining main bearing caps and the crankshaft lower main bearings.

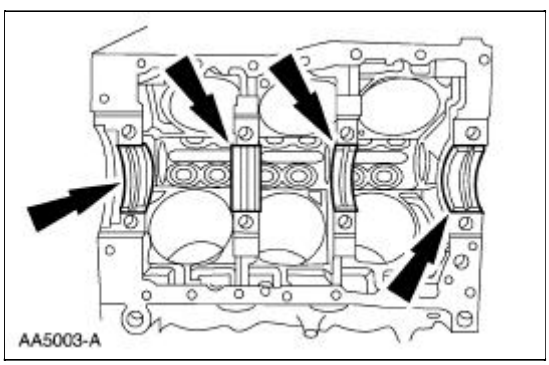
67. **CAUTION: The crankshaft journals must be protected from damage when the crankshaft is removed.**

Remove the crankshaft and the crankshaft rear seal.

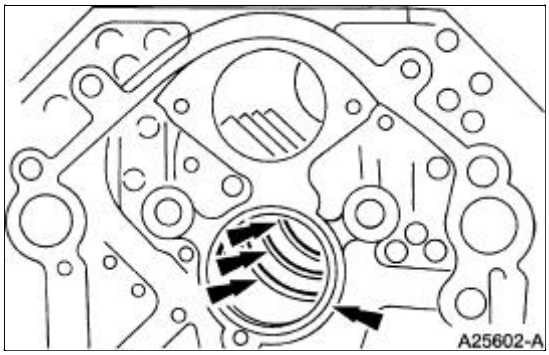


68. **NOTE:** For ease in assembly, record the location of the crankshaft upper thrust bearing.

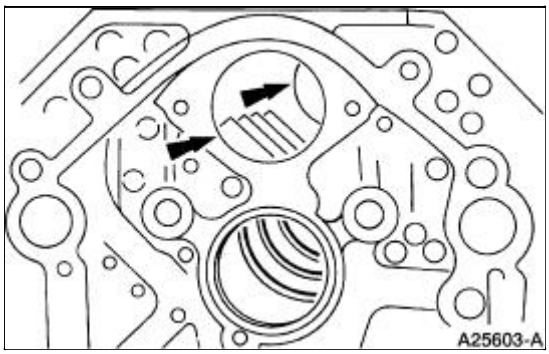
Remove the crankshaft upper main bearings and the crankshaft upper thrust bearing.



69. Using the camshaft bearing service set, remove the camshaft bearings.



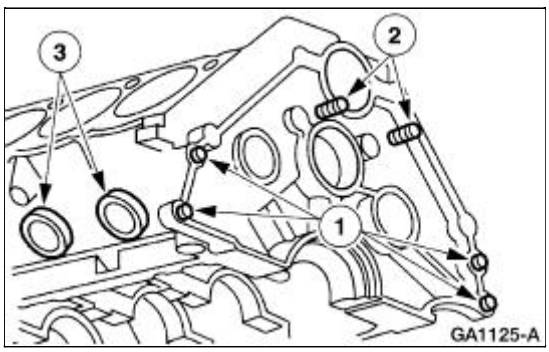
70. Using the camshaft bearing service set, remove the engine dynamic balance shaft bearings.



71. If equipped, remove the engine block heater. For additional information, refer to Section 303-03A .

72. **NOTE:** For cleaning purposes, the plugs should be removed.

If necessary, remove the following:
1. the cylinder block dowels.
2. the oil gallery plugs.
3. the water jacket plugs.



Cylinder Head

Special Tool(s)

ST1383-A	Compressor, Valve Spring 303-163 (T81P-6513-A)

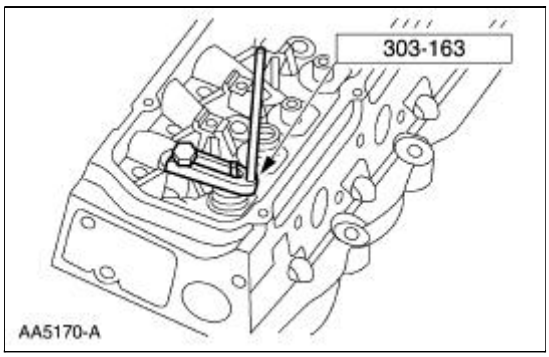
Material

Item	Specification
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

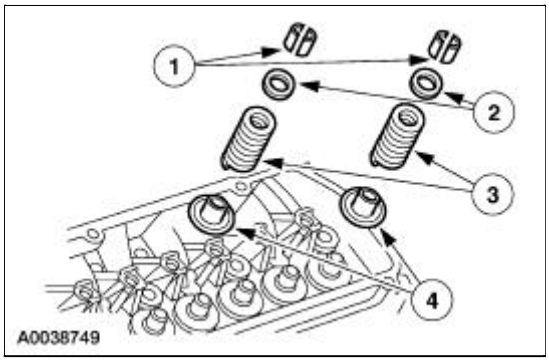
Disassembly and Assembly

CAUTION: If the components are to be reinstalled, they must be installed in the same position. Mark the components removed for location.

1. Remove the spark plugs (12405) if necessary.
2. Using the special tool, compress the valve springs (6513).



3. Remove the following:
    1. The valve spring retainer key (6518).
    2. The valve spring retainers (6514).
    3. The valve springs (6513).
    4. The valve stem seals and seats (6A517).



4. Inspect the components. For additional information, refer to Section 303-00 .

5. **CAUTION: Lubricate the parts with clean engine oil before installing.**

   To assemble, reverse the disassembly procedure.

Piston

Special Tool(s)

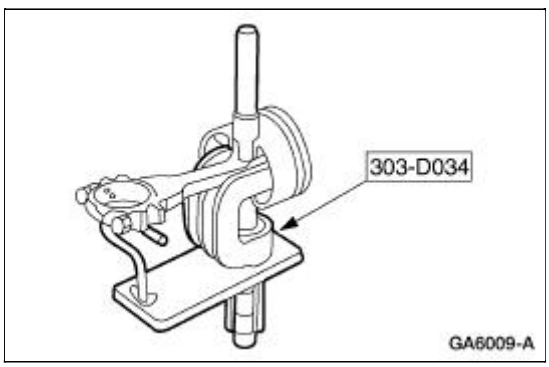
ST1336-A	Piston Pin Tool or equivalent 303-D034 (D81L-6135-A)

Material

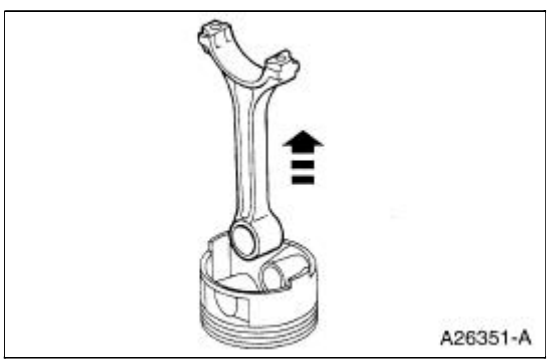
Item	Specification
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

Disassembly

1. Using the special tool, press the piston pin out from the connecting rod and piston assembly.



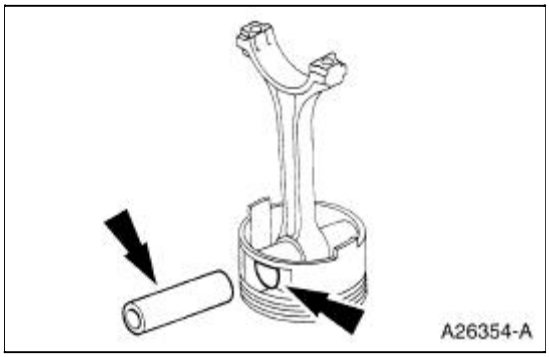
2. Remove the connecting rod from the piston.



3. Clean and inspect the connecting rod and piston. For additional information, refer to Section 303-00 .

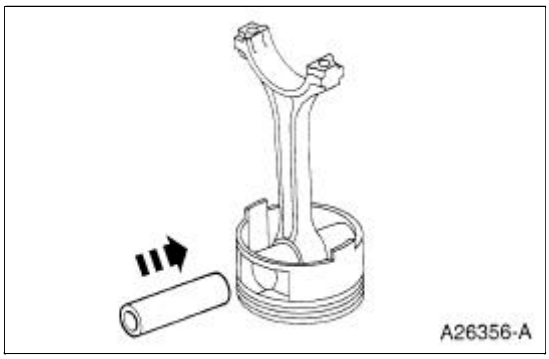
Assembly

1. Lubricate the piston pin and piston pin bore with clean engine oil.

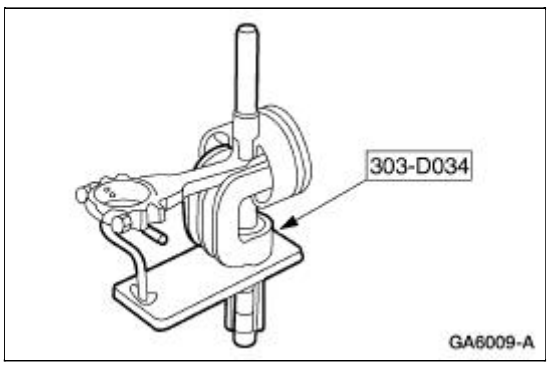


2. **NOTE:** The connecting rod can be installed in either direction.

   Position the piston pin in the bore aligned with the connecting rod bore.

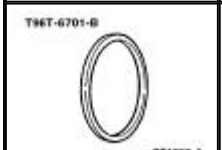
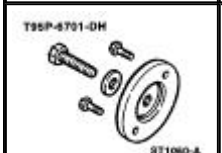


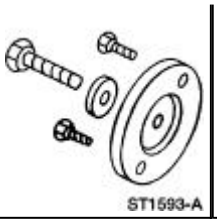
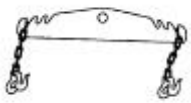
3. Using the special tool, press the piston pin into the piston and rod assembly.



Engine

Special Tool(s)

ST1185-A	Slide Hammer 307-005 (T59L-100-B)
ST1378-A	Remover Adapter, Vibration Damper 303-176 (T82L-6316-B)
ST1379-A	Installer, Crankshaft Front Seal 303-474 (T94P-6701-AH)
	Replacer, Steering Pump Pulley 211-009 (T65P-3A733-C)
ST2337-A	Engine Lift Bracket Set 303-D095 (D94L-6001-A)
	Replacer, Rear Crankshaft Seal 303-516 (T95P-6701-BH)
	Spacer, Rear Crank Seal Replacer 303-561 (T96T-6701-B)
	Adapter, Crankshaft Rear Seal (Use only the adapter retaining bolts) 303-518 (T95P-6701-DH)

 ST1593-A	Adapter, Crankshaft Rear Seal (Use only the adapter and the center jack screw) 303-S560 (T96T-6701-A)
 ST1602-A	Spreader Bar 303-D089 (D93P-6001-A3)

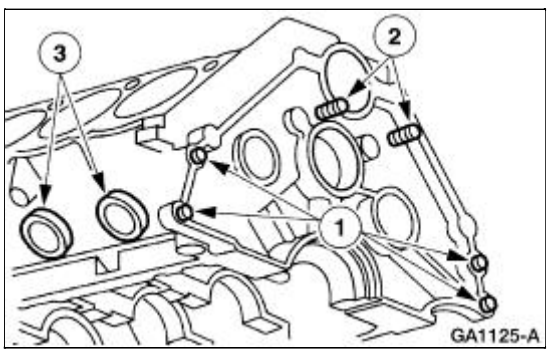
Material

Item	Specification
Metal Surface Cleaner F4AZ-19A536-RA or equivalent	WSE-M5B392-A
Silicone Gasket and Sealant F7AZ-19554-EA or equivalent	WSE-M4G323-A4
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H
Pipe Sealant with Teflon® XW7Z-19554-AA	WSK-M2G350-A2

CAUTION: The moving components must be lubricated with clean engine oil before assembly.

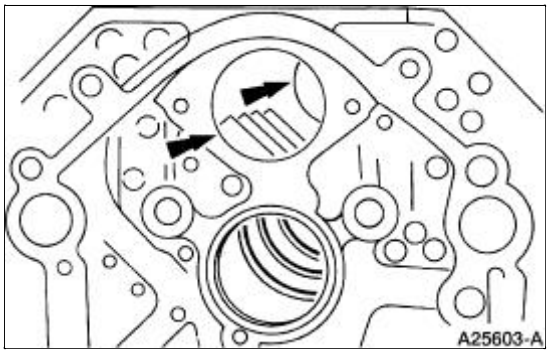
CAUTION: The components with oil holes must be correctly aligned with the oil feed holes.

1. If necessary, install the following:
    1. the cylinder block dowels.
    2. the oil gallery plugs.
    3. the water jacket plugs.

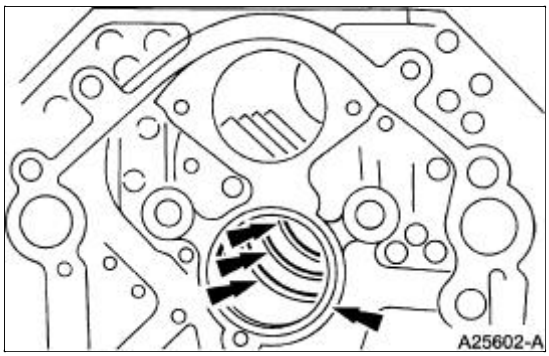


2. If equipped, install the engine coolant heater. For additional information refer to Section 303-03A .

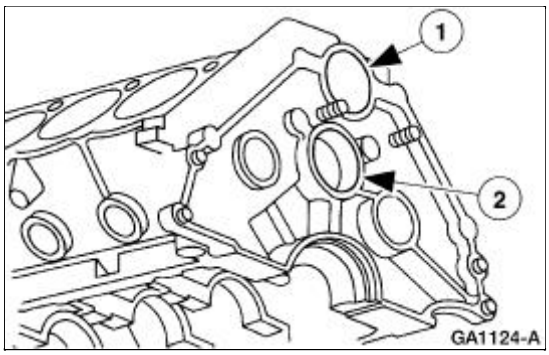
3. Using the camshaft bearing service set, install the engine dynamic balance shaft bearings.



4. Using the camshaft bearing service set, install the camshaft bearings.

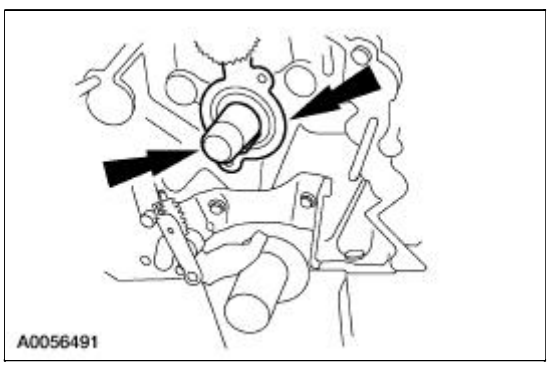


5. Install the following:
    1. the engine dynamic balance shaft bearing cover.
    2. the camshaft bearing cover.

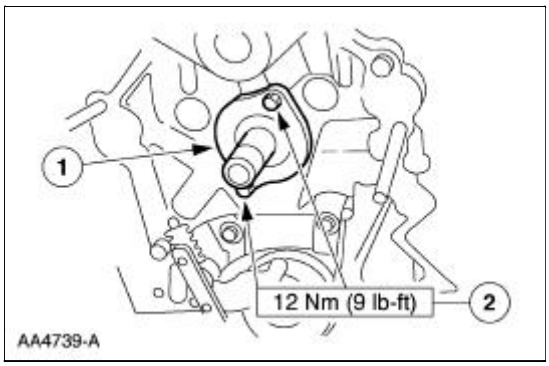


6. **CAUTION: Do not damage the camshaft lobes when installing the camshaft.**

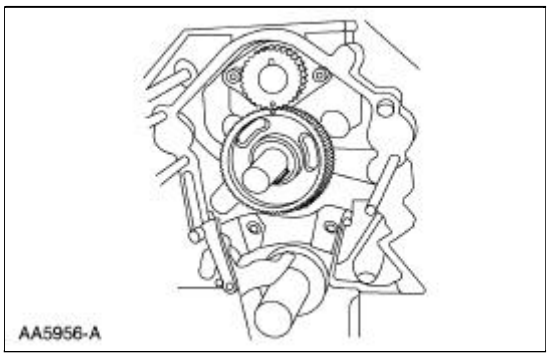
    Install the camshaft and the camshaft spacer.



7. Install the camshaft thrust plate.
    1. Position the camshaft thrust plate.
    2. Install the bolts.

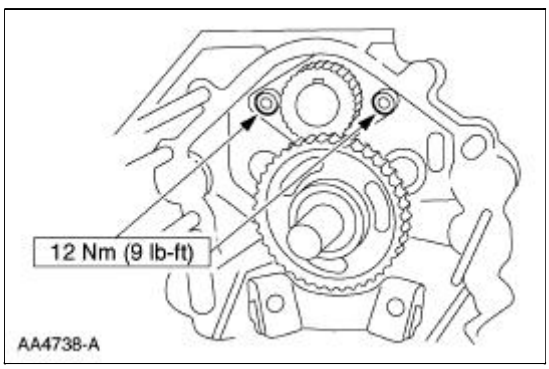


8. Turn the camshaft so that the timing mark is at 12 o'clock and install the engine dynamic balance shaft assembly into the cylinder block. Turn the engine balance shaft driven gear so that the timing mark aligns up with the timing mark on the engine balance shaft drive gear.



9. **NOTE:** If correctly aligned, the engine dynamic balance shaft keyway will be at 12 o'clock and the camshaft keyway will be at 6 o'clock on the camshaft.

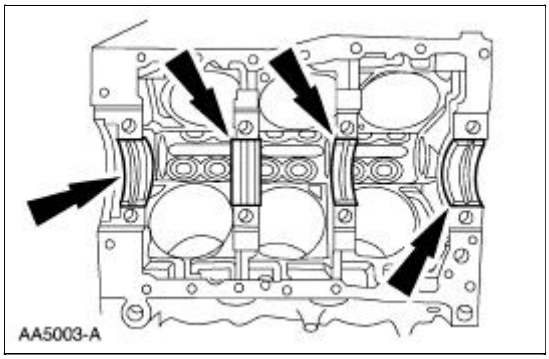
    Install the bolts.



10. **CAUTION: Make sure the components are installed in the correct location.**

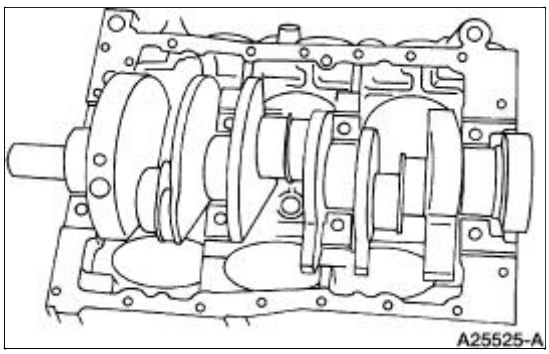
    NOTE: Lubricate the crankshaft main bearings prior to installation.

    Install the crankshaft upper main bearings and the crankshaft upper thrust main bearing.



11. **CAUTION: The crankshaft journals must be protected from damage when installing the crankshaft.**

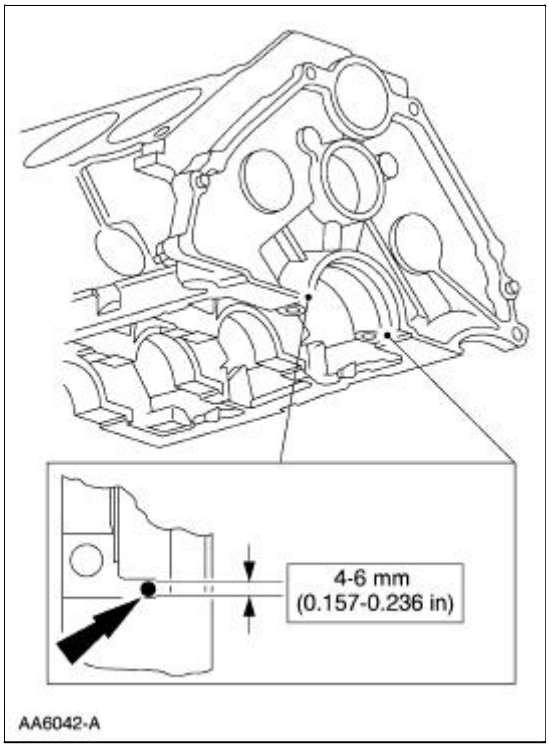
    Position the crankshaft.



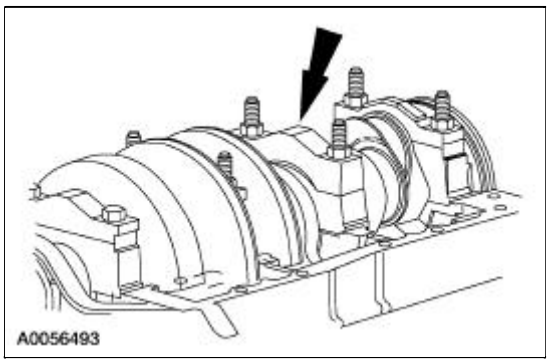
CAUTION: The main bearings are precision selective fit. Inspect the bearing clearance. For additional information, refer to Section 303-00 .

12. **NOTE:** If the rear main bearing cap is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.

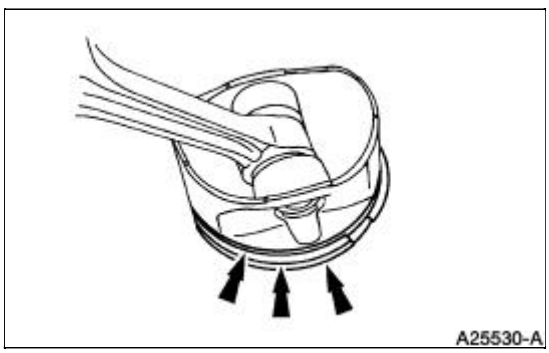
    Clean the rear main bearing cap sealing area with metal surface cleaner. Apply silicone gasket and sealant to the rear main bearing cap-to-cylinder block parting line.



13. Install the main bearing caps. Tighten the bolts in two stages:
    - Stage 1: Tighten to 50 Nm (37 lb-ft).
    - Stage 2: Rotate an additional 120 degrees.



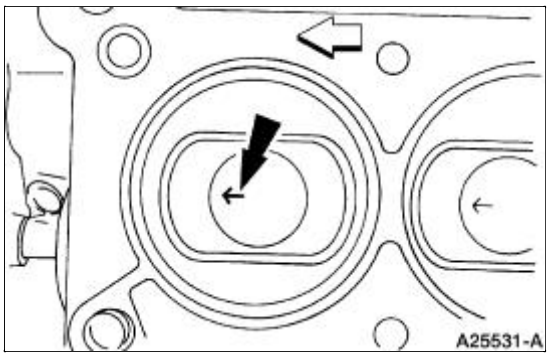
14. Compress the piston rings.



15. **CAUTION: Inspect the piston clearance. For additional information, refer to Section 303-00 .**

CAUTION: Do not damage the cylinder wall with the sharp edges of the connecting rod.

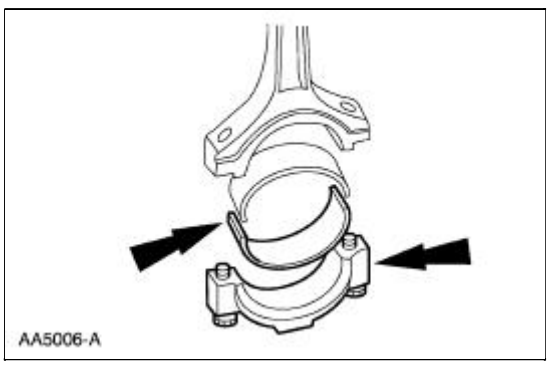
Install the piston with the arrow on the piston face pointing toward the front of the engine.



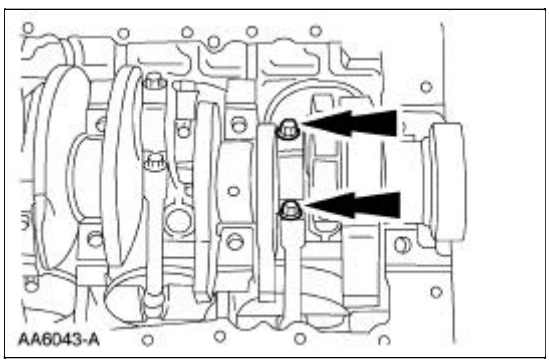
16. **CAUTION: Inspect the connecting rod bearing clearance. For additional information, refer to Section 303-00 .**

CAUTION: The connecting rod cap will fit only one way.

Position the connecting lower rod bearing and the connecting rod cap on the connecting rod and the crankshaft journal.

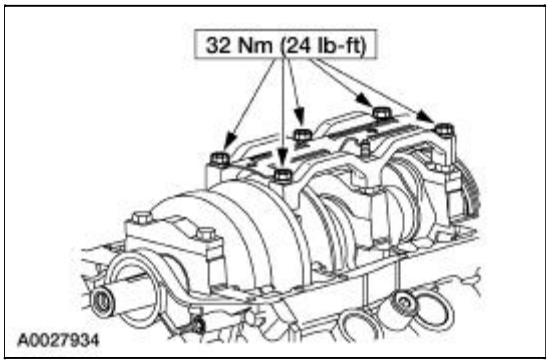


17. Install the rod caps. Tighten the bolts in three stages:
    - Stage 1: Tighten to 25 Nm (18 lb-ft).
    - Stage 2: Tighten to 45 Nm (33 lb-ft).
    - Stage 3: Tighten an additional 105 degrees.

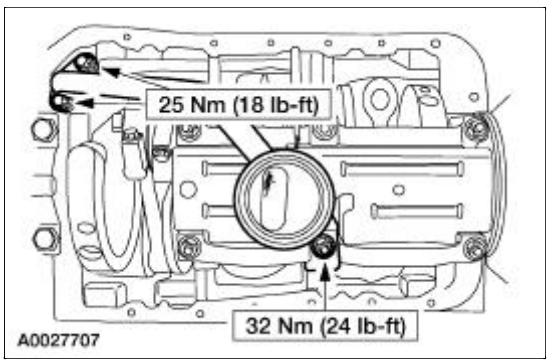


18. Install the remaining pistons and the connecting rods.

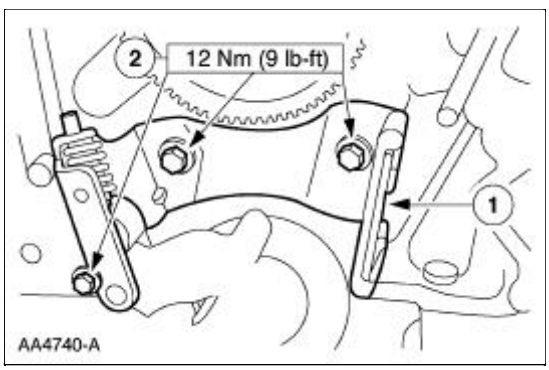
19. Install the oil pan bridge and baffle assembly.



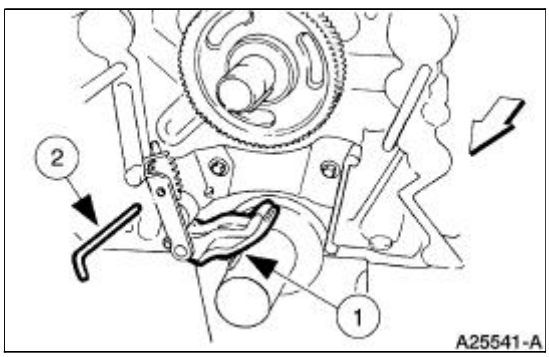
20. Using a new gasket, install the oil pump screen cover and tube.



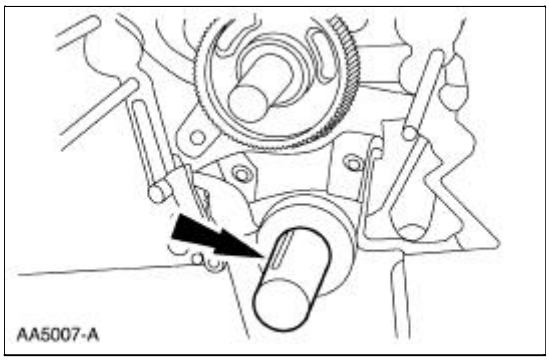
21. Install the timing chain tensioner.
    1. Position the timing chain tensioner.
    2. Install the bolts.



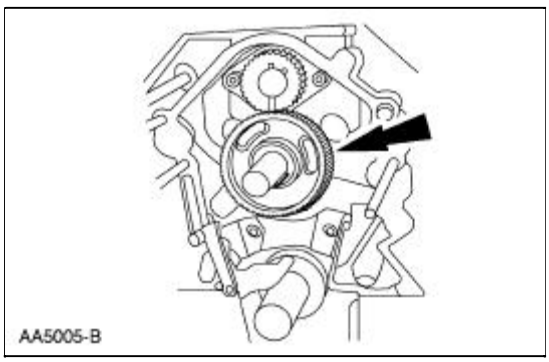
22. Retract the tensioner pad retracting mechanism.
    1. Compress the tensioner pad retracting mechanism.
    2. Insert a retaining pin.



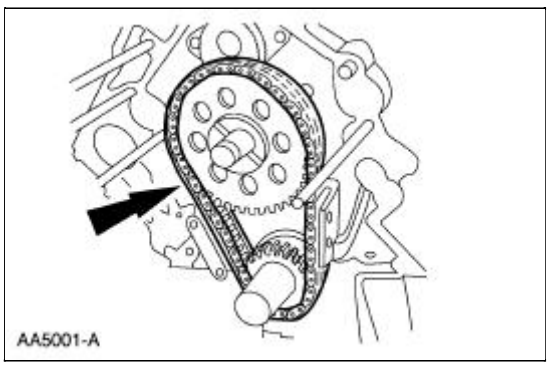
23. Rotate the crankshaft so the number one piston is at top dead center (TDC) and the key is at the 12 o'clock position.



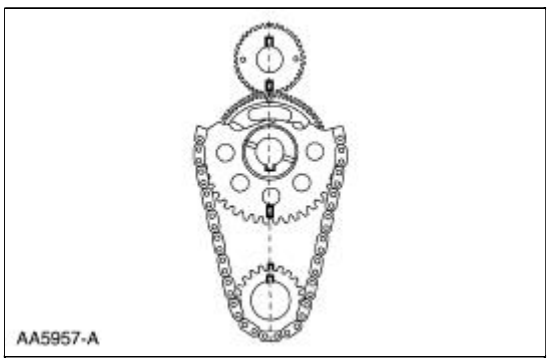
24. Turn the camshaft sprocket so that the keyway is on the bottom of the camshaft.



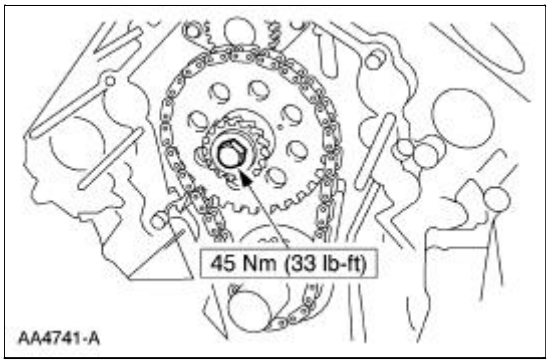
25. Install the timing chain, the camshaft sprocket and the crankshaft sprocket as an assembly.



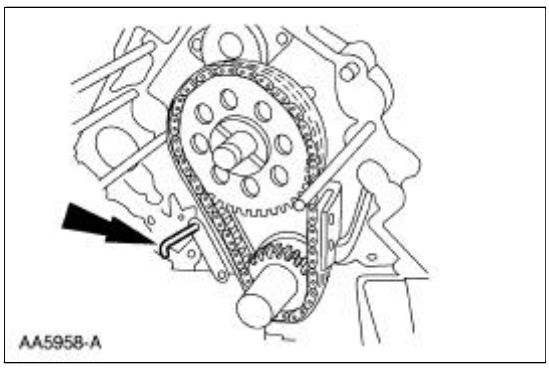
26. Make sure the timing marks and the keyways are aligned.



27. Install the camshaft position sensor drive gear and retaining bolt.



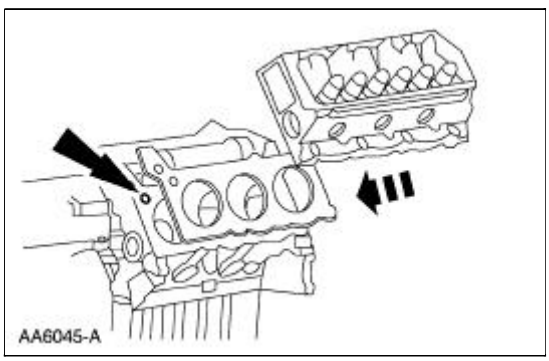
28. Remove the retaining pin.



CAUTION: The components removed should be marked for location. Make sure the used parts are installed in the correct location.

29. **NOTE:** Install the new cylinder head gaskets with the small hole to the front of the engine.

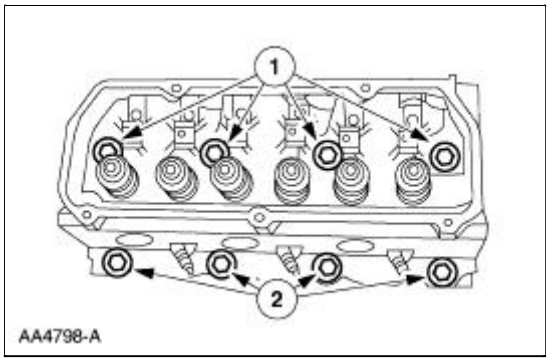
    Using new gaskets, install the RH and the LH cylinder heads.



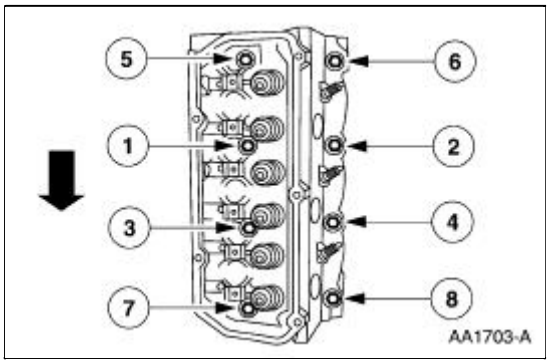
30. **CAUTION: Always use new bolts.**

    NOTE: Lubricate the bolts with clean engine oil prior to installation.

    Position the new bolts.
    1. Position the new long bolts.
    2. Position the new short bolts.

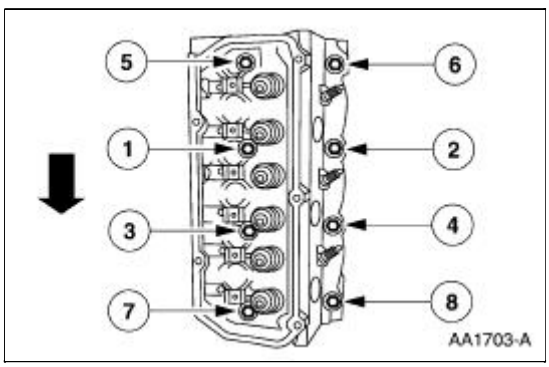


31. Tighten the bolts in three stages in the sequence shown:
    - Stage 1: Tighten to 20 Nm (15 lb-ft).
    - Stage 2: Tighten to 40 Nm (30 lb-ft).
    - Stage 3: Tighten to 50 Nm (37 lb-ft).



32. **CAUTION: Do not loosen all of the bolts at one time. Each bolt must be loosened and tightened prior to working on the next bolt in the sequence.**

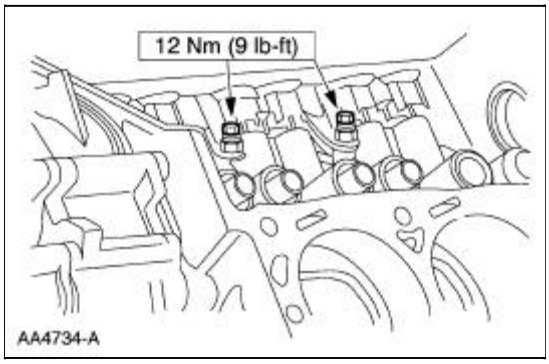
    Tighten the bolts in four stages in the sequence shown: short bolts numbered 2, 4, 6 and 8:
    - Stage 1: Tighten to 25 Nm (18 lb-ft).
    - Stage 2: Tighten an additional 180 degrees.
      Long bolts numbered 1, 3, 5 and 7:
    - Stage 3: Tighten to 45 Nm (33 lb-ft).
    - Stage 4: Tighten an additional 180 degrees.



33. **NOTE:** Lubricate the valve tappets with clean engine oil prior to installing.

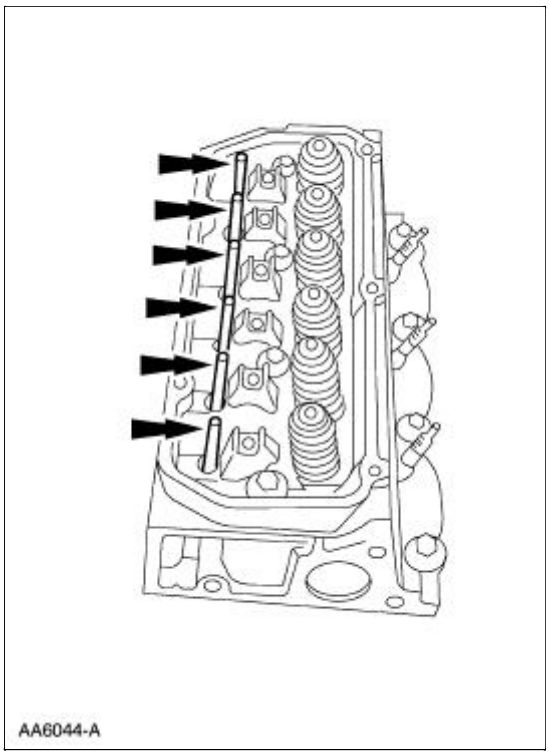
    Install the valve tappets.

- Install the valve tappets.
- Install the tappet guide plates and retainers.
- Install the bolts.



34. **NOTE:** Lubricate the push rods with clean engine oil prior to installation.

    Install the 12 push rods.



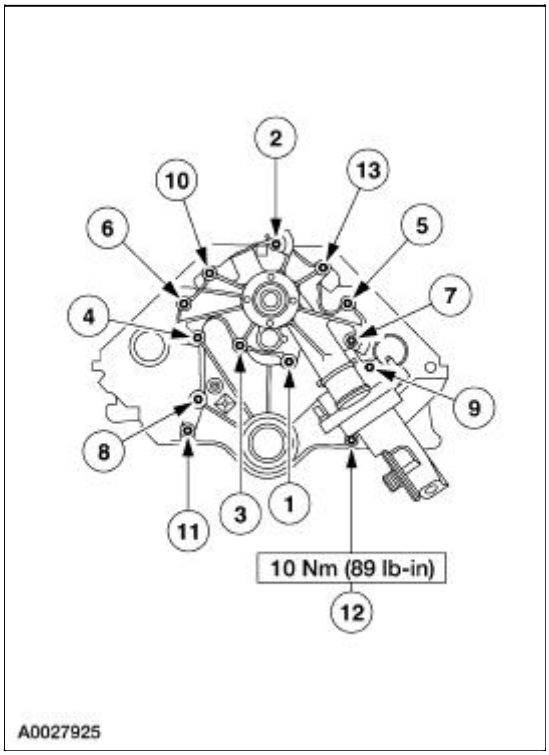
35. Install the 12 rocker arms. For additional information, refer to Rocker Arm in this section.

36. **NOTE:** Use pipe sealant with Teflon® on studs No. 4 and 6, and bolt No. 12.

    Using a new gasket, install the engine front cover. Tighten the nuts and the bolts in the sequence shown.

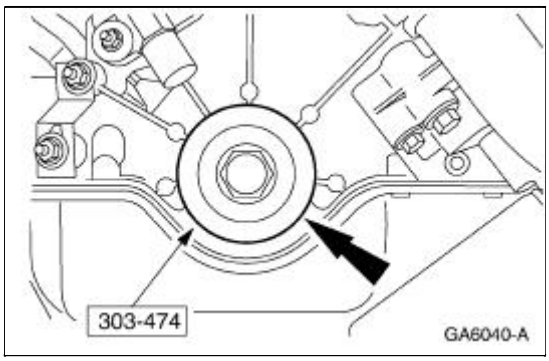
    - Install a 135.5 mm (5.42 in) stud at location No. 5 and tighten to 7 Nm (62 lb-in).
    - Install a 137 mm (5.48 in) stud at locations No. 4, 6, 7 and 10, and tighten to 7 Nm (62 lb-in).
    - Using a new gasket, install the water pump.
    - Tighten bolt No. 12 to 10 Nm (89 lb-in). All other nuts and bolts are to be tightened to 28

Nm (21 lb-ft).

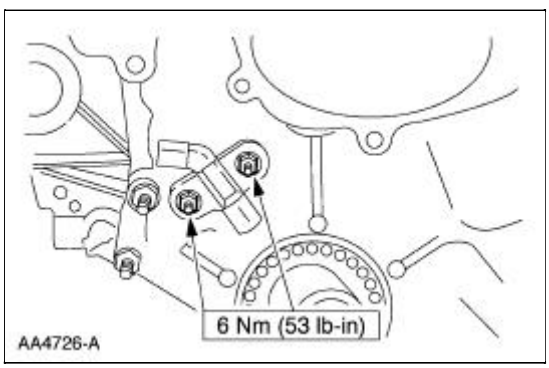


37. **NOTE:** Lubricate the parts with clean engine oil before assembly.

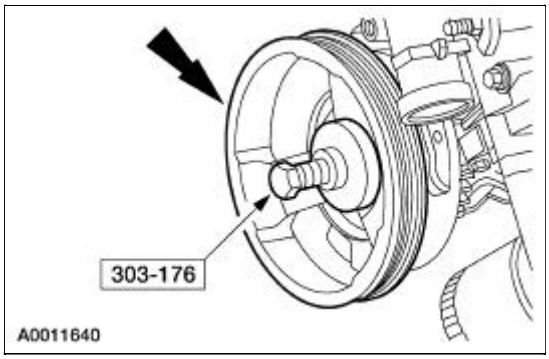
    Using the special tool, install the front crankshaft seal.



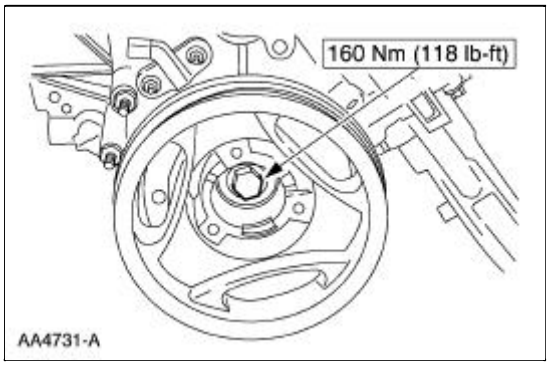
38. Install the crankshaft position sensor.



39. Apply a bead of silicone gasket and sealant to the keyway in the crankshaft damper. Using the special tool, position and install the crankshaft damper.

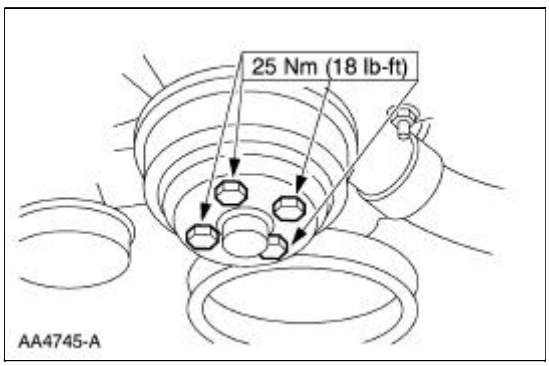


40. Install the crankshaft pulley bolt.



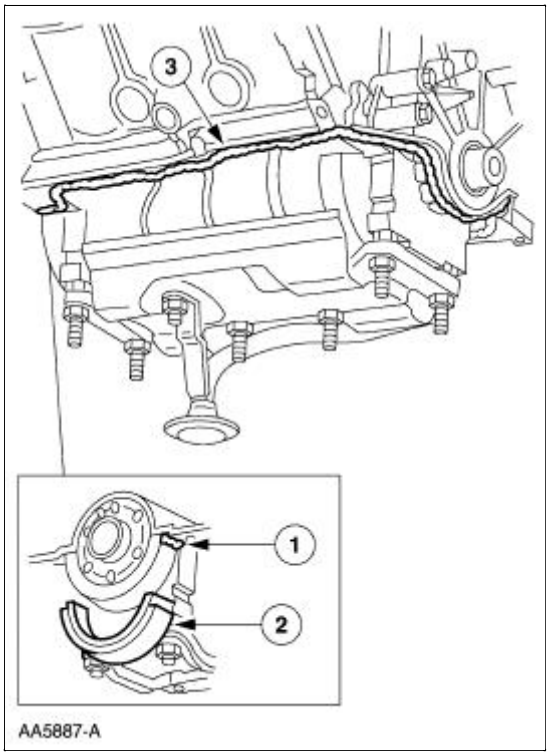
41. Install the camshaft synchronizer. For additional information, refer to Section 303-14 .

42. Install the water pump pulley and the retaining bolts.

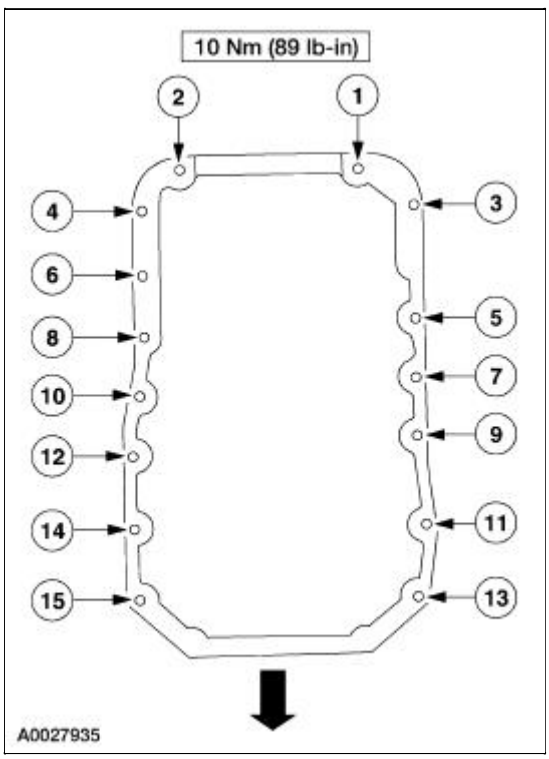


43. **NOTE:** If the oil pan is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.

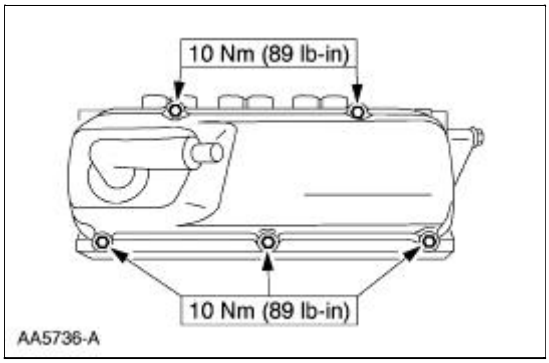
    Clean and apply the sealant to the oil pan sealing areas shown and install the oil pan rear seal.
    1. Apply silicone gasket and sealant to the rear main bearing cap.
    2. Install the oil pan rear seal.
    3. Clean the oil pan mating surfaces with metal surface cleaner and apply silicone gasket and sealant to the oil pan mating surface.



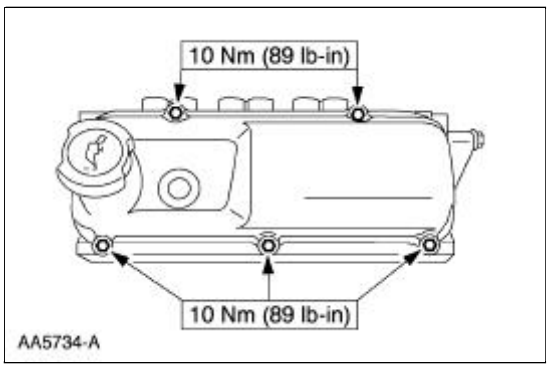
44. Tighten the oil pan bolts in the sequence shown.



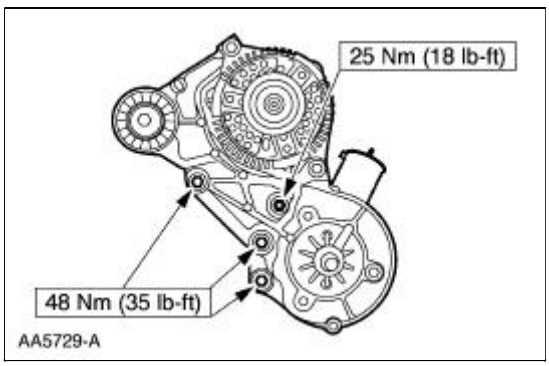
45. Install the RH valve cover.



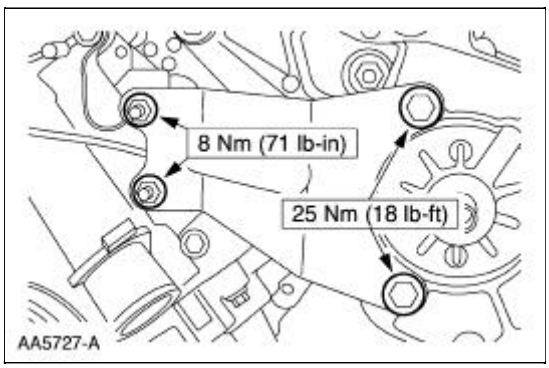
46. Install the LH valve cover.



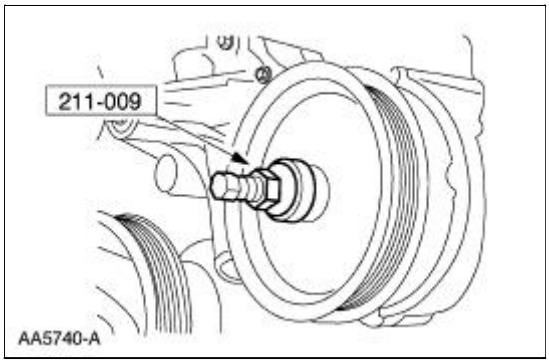
47. Install the generator mounting bracket.



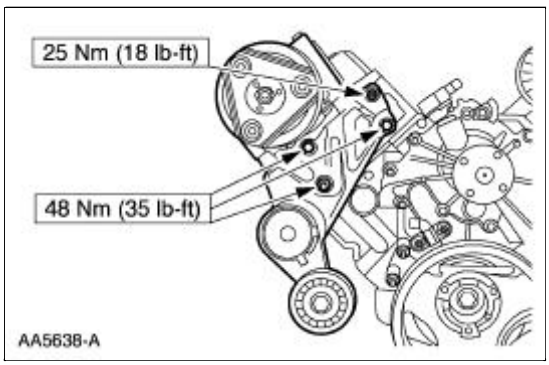
48. Install the power steering pump bracket.



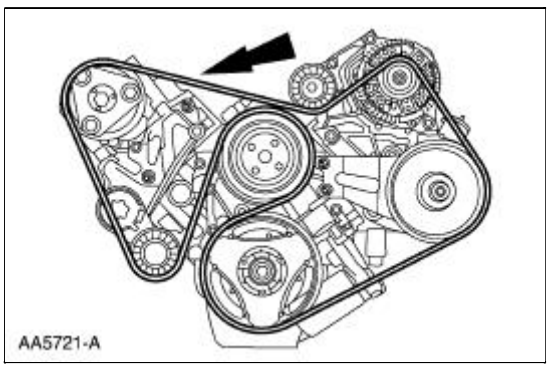
49. Using the special tool, install the power steering pump pulley.



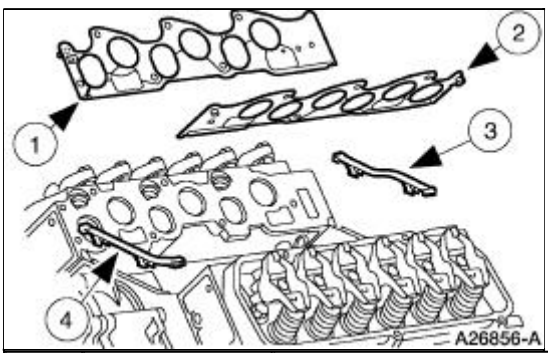
50. Install the A/C compressor bracket and the bolts.



51. Install the accessory drive belt.



52. Refer to the illustration for intake manifold sealing components.

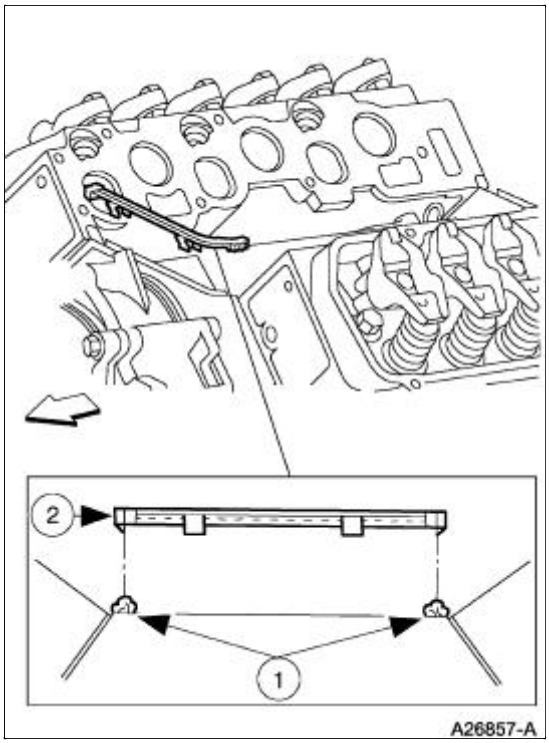


Item	Part Number	Description
1	9439	Intake manifold gasket, RH
2	9441	Intake manifold gasket, LH
3	9A424	Intake manifold rear end seal (part of 9439)

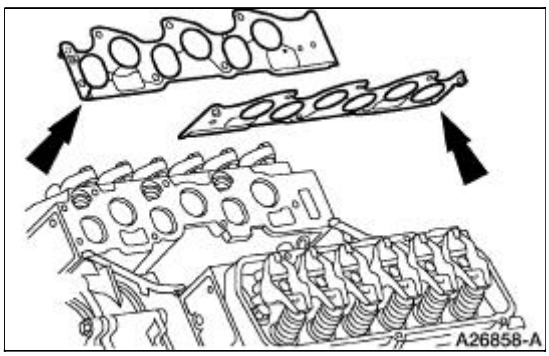
4	9A425	Intake manifold front end seal (part of 9439)

53. **NOTE:** If the lower intake manifold is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.

    Install the lower intake manifold front and rear end seals.
    1. Apply a bead of silicone gasket and sealant to the intake manifold front and rear end seal mounting points as indicated.
    2. Install the lower intake manifold front and rear end seals.

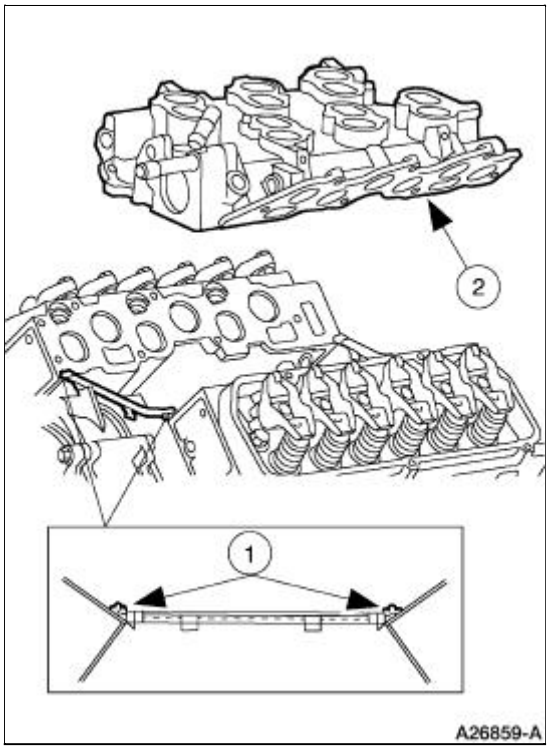


54. Install the intake manifold gaskets.

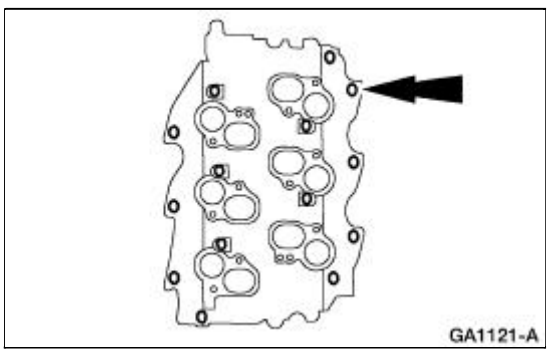


55. **NOTE:** If the lower intake manifold is not secured within four minutes, the sealant must be removed and the sealing area cleaned with metal surface cleaner. Allow to dry until there is no sign of wetness, or four minutes, whichever is longer. Failure to follow this procedure can cause future oil leakage.

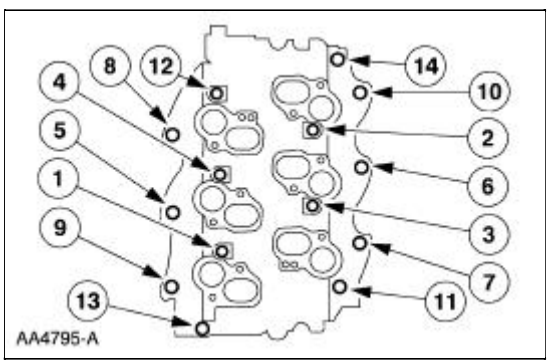
    Position the lower intake manifold.
    1. Apply a bead of silicone gasket and sealant to the lower intake manifold mounting at the points indicated.
    2. Position the lower intake manifold.



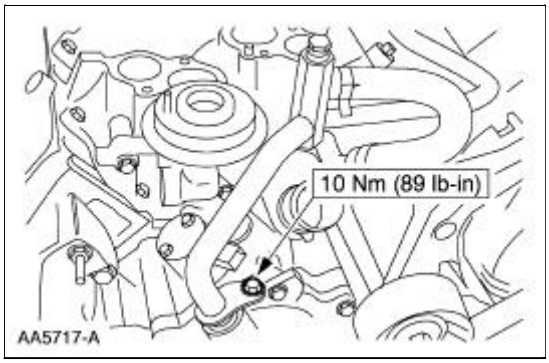
56. Install the lower intake manifold bolts.
    - Install the six long bolts.
    - Install the eight short bolts.



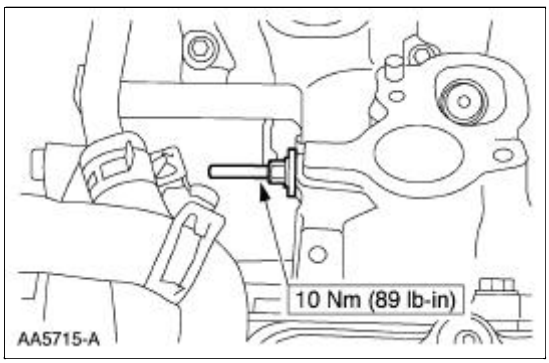
57. Tighten the bolts in two stages in the sequence shown.
    1. Stage 1: Tighten to 5 Nm (44 lb-in).
    2. Stage 2: Tighten to 10 Nm (89 lb-in).



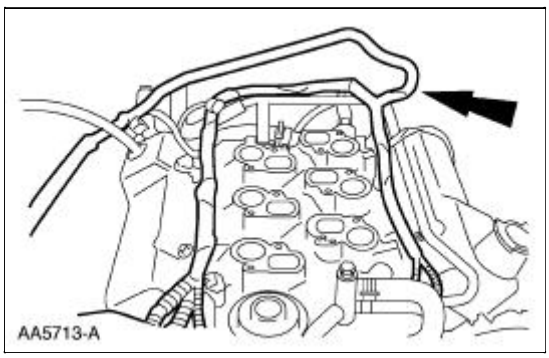
58. Install the heater water outlet tube.



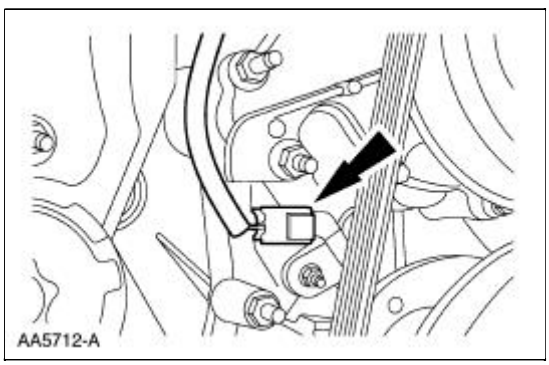
59. Install the stud bolt.



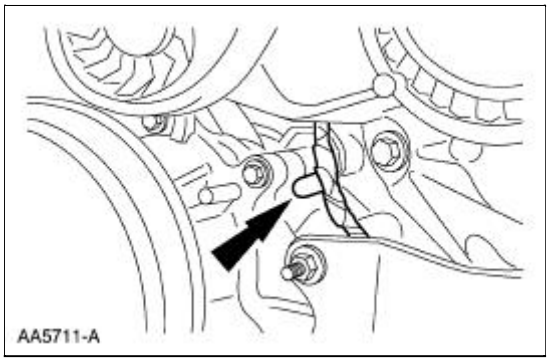
60. Position the engine wire harness.



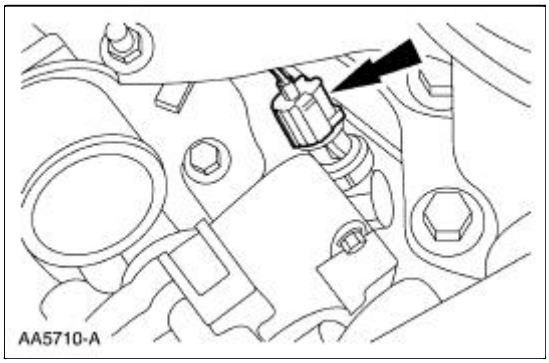
61. Connect the crankshaft position sensor electrical connector.



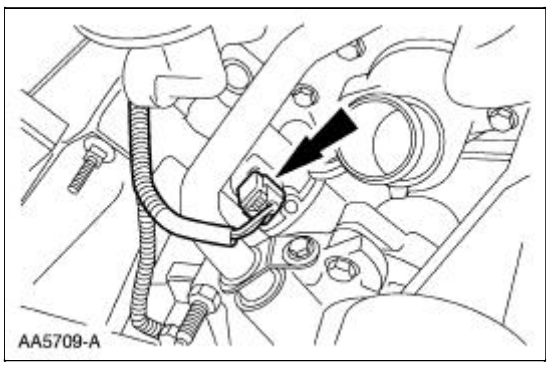
62. Install the pin-type retainer.



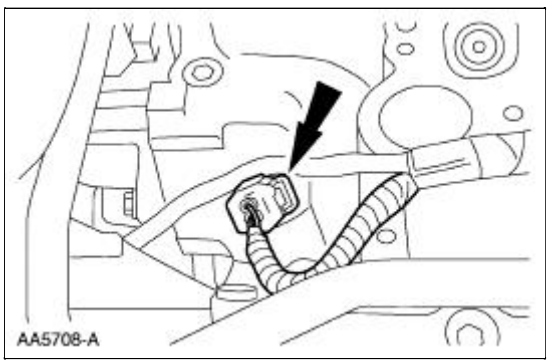
63. Connect the engine oil pressure sender electrical connector.



64. Connect the camshaft position (CMP) sensor electrical connector.

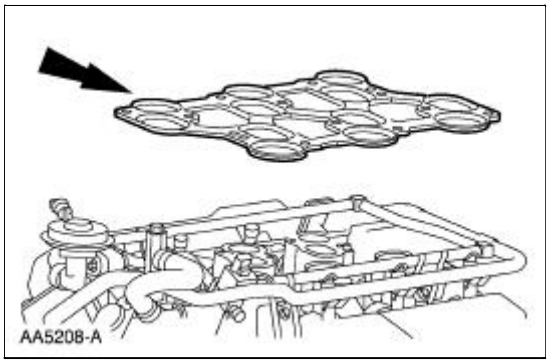


65. Connect the cylinder head temperature (CHT) sensor.



66. Install the fuel injectors and the fuel injection supply manifold as an assembly. For additional information, refer to Section 303-04A .

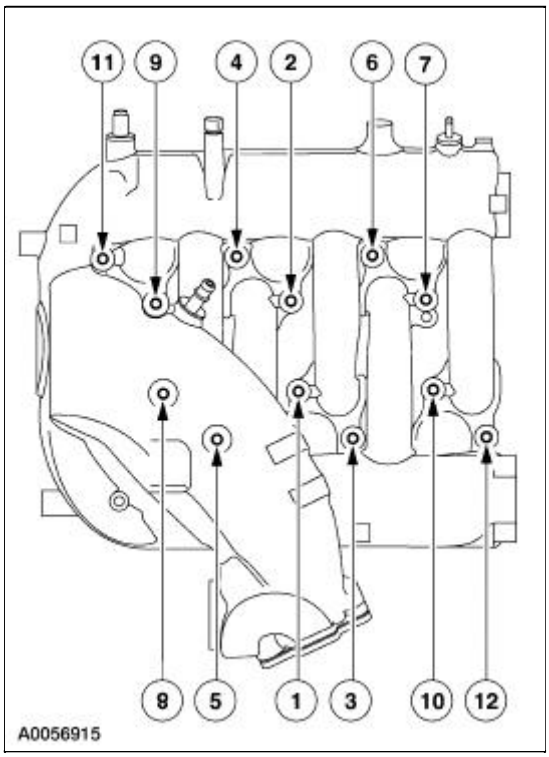
67. Install a new upper intake manifold gasket.



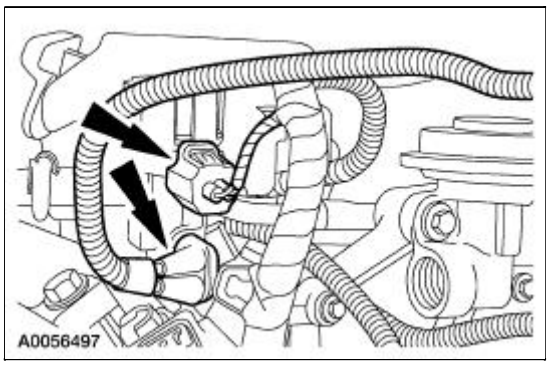
68. **NOTE:** Refer to the location note made during removal and make sure the bolts are installed in the correct location.

    Install the upper intake manifold. Tighten the bolts in two stages in the sequence shown.

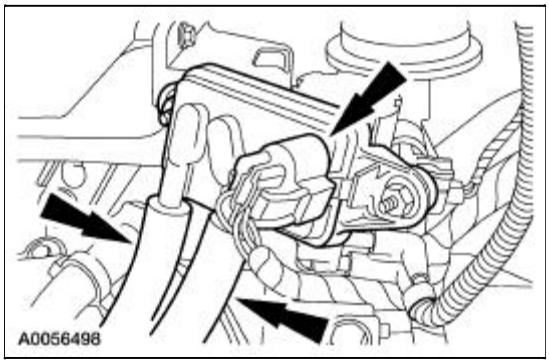
    - Stage 1: Tighten to 10 Nm (89 lb-in).
    - Stage 2: Rotate an additional 90 degrees.



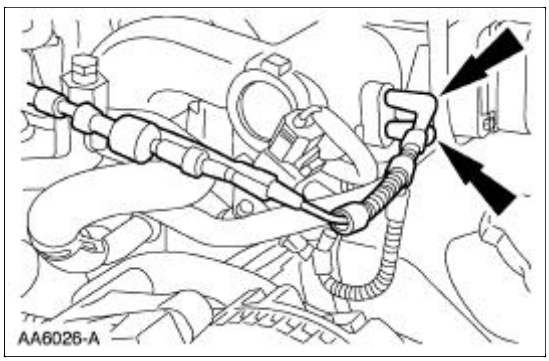
69. Connect the exhaust gas recirculation (EGR) vacuum regulator solenoid electrical and vacuum connections.



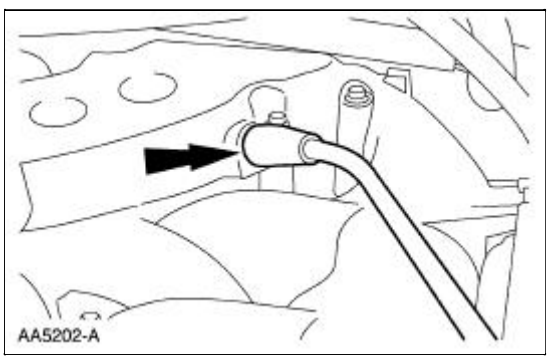
70. Connect the differential pressure feedback EGR system electrical and vacuum connections.



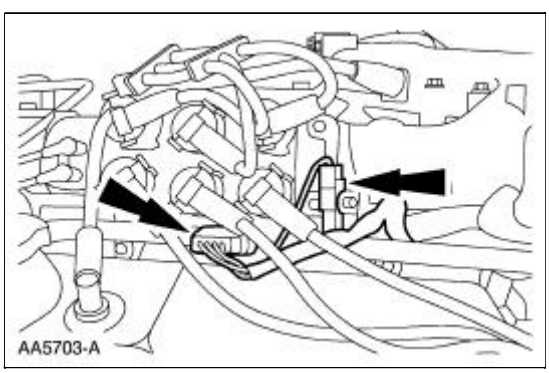
71. Connect the vacuum hoses.



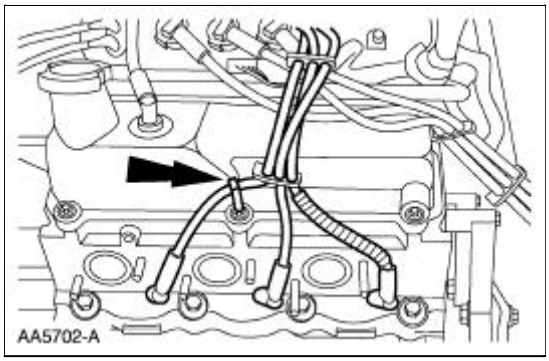
72. Install the positive crankcase ventilation (PCV) tube.



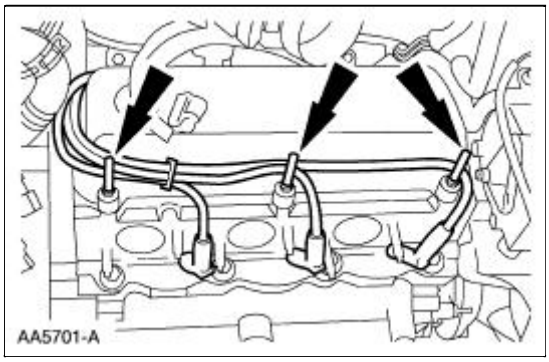
73. Connect the ignition coil and the radio interference capacitor electrical connectors.



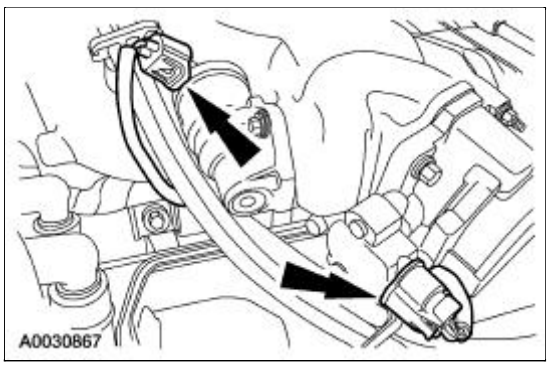
74. Position and connect the LH spark plug wires.



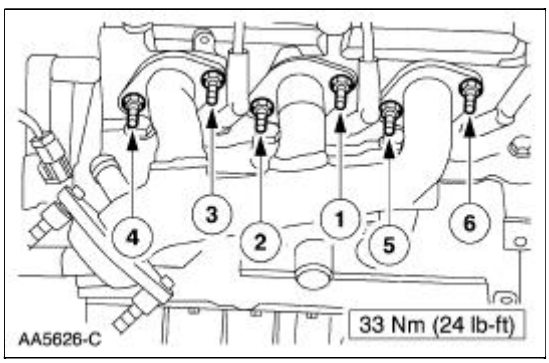
75. Position and connect the RH spark plug wires.



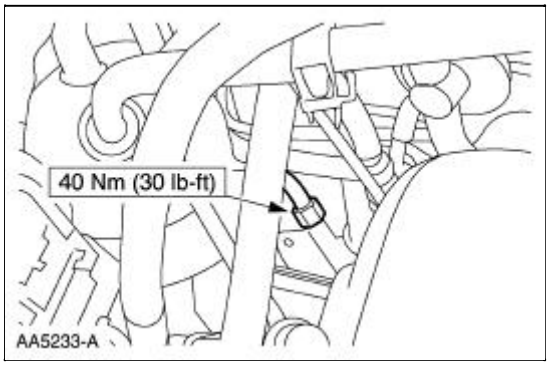
76. Connect the idle air control (IAC) valve and the throttle position (TP) sensor electrical connectors.



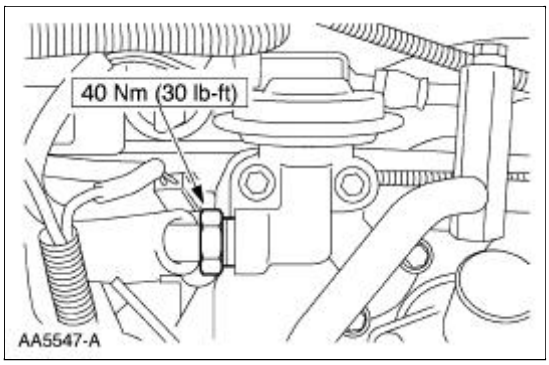
77. Install the RH exhaust manifold.
    - Install a new exhaust manifold gasket.
    - Install the exhaust manifold.
    - Tighten the nuts in the sequence shown.



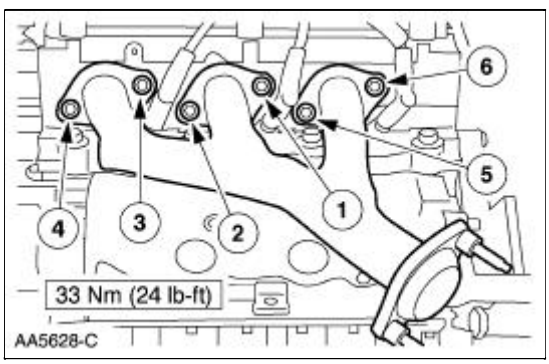
78. Install the exhaust gas recirculation (EGR) tube.



79. Connect the EGR valve nut.

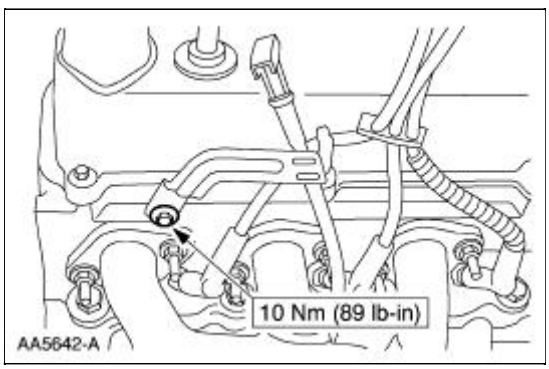


80. Using a new gasket, install the LH exhaust manifold. Tighten the nuts in the sequence shown.

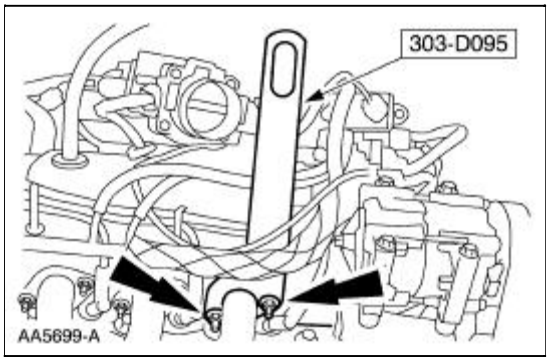


81. **NOTE:** Install a new O-ring seal.

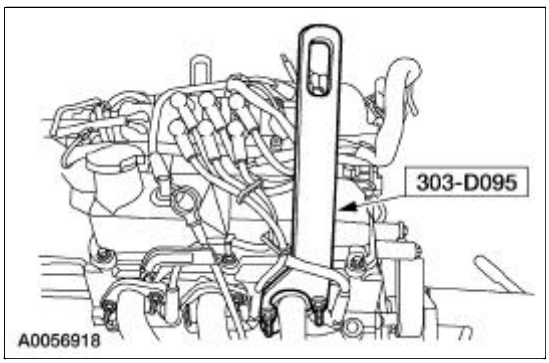
    Install the oil level indicator and tube and retaining bolt.



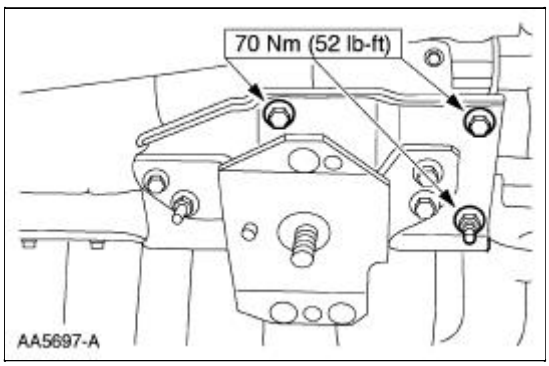
82. Install the special tool.



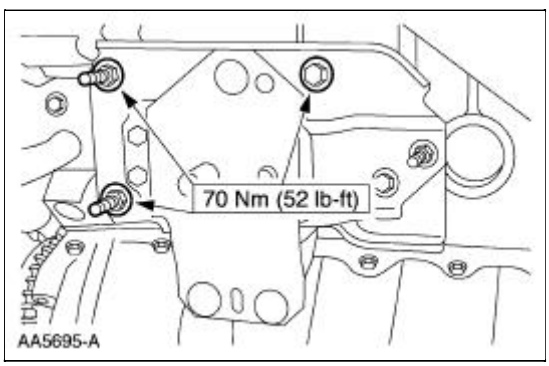
83. Install the special tool.



84. Install the RH engine support insulator.



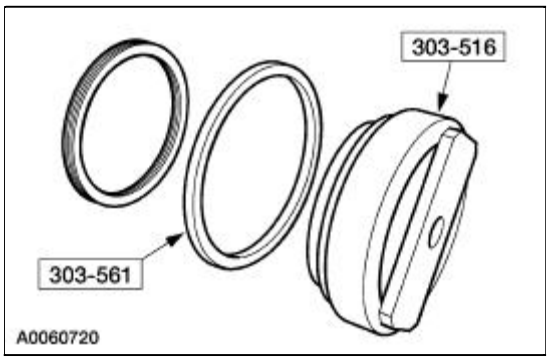
85. Install the LH engine support insulator.



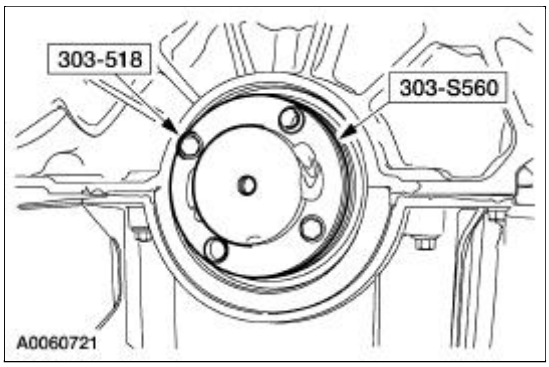
86. Remove the engine from the stand.

87. **NOTE:** Lubricate the crankshaft rear seal lips with clean engine oil prior to installation.

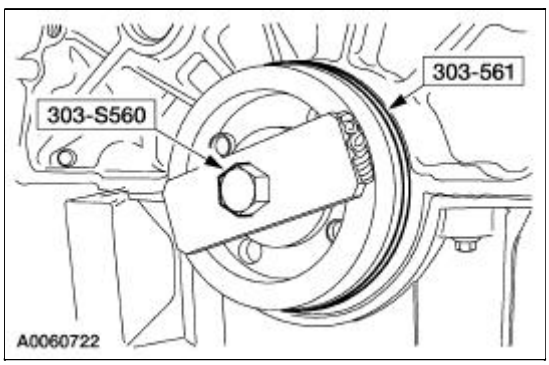
    Assemble the special tools and the crankshaft rear seal.



88. Install the special tools on the rear of the crankshaft.

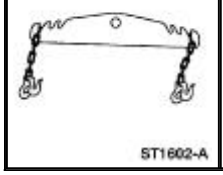


89. Install the crankshaft rear seal. Tighten the center jack screw (303-S560) until the spacer (303-561) contacts the engine block.



Engine

Special Tool(s)

ST1341-A	Heavy Duty Floor Crane 014-00071 or equivalent
 ST1602-A	Spreader Bar 303-D089 (D93P-6001-A3) or equivalent

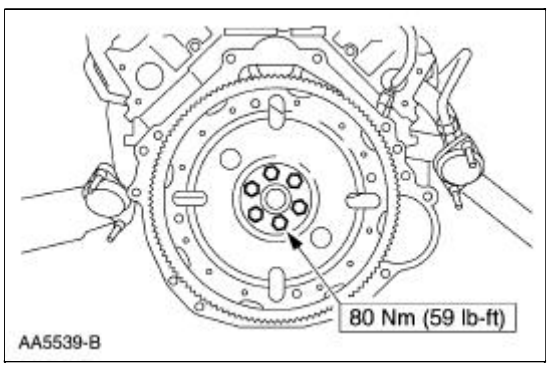
Material

Item	Specification
SAE 5W-20 Premium Synthetic Blend Motor Oil XO-5W20-QSP or equivalent	WSS-M2C153-H

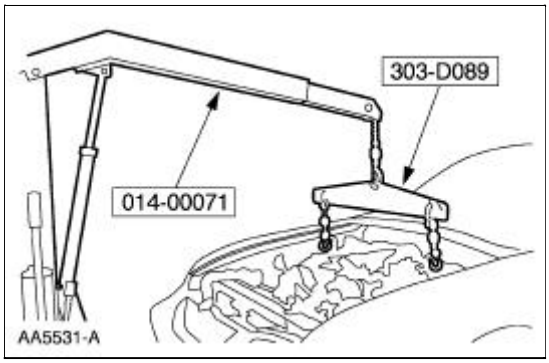
Installation

All vehicles

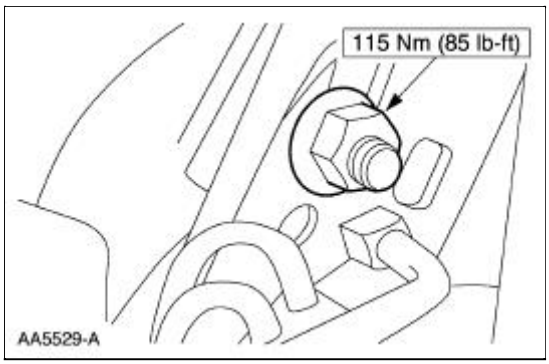
1. Install the separator plate and the flywheel.



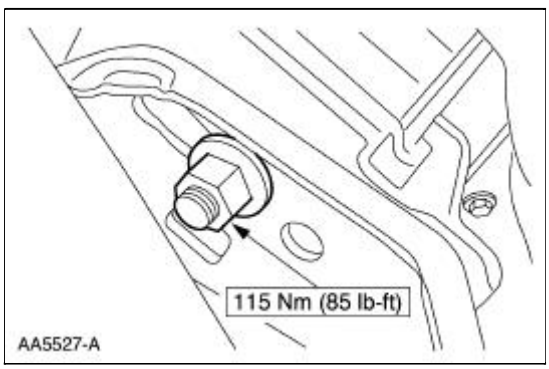
2. Using the special tools, position the engine in the vehicle.



3. Remove the special tools.
4. Raise and support the vehicle. For additional information, refer to Section 100-02 .
5. Install the LH engine mount nut.

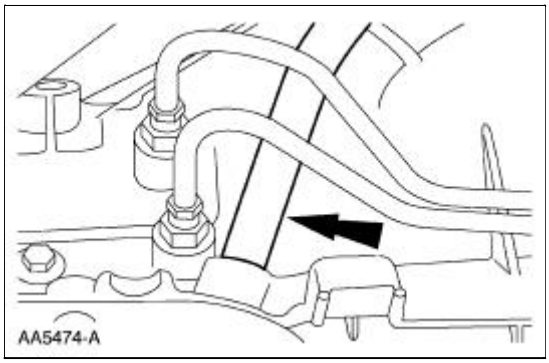


6. Install the RH engine mount nut.



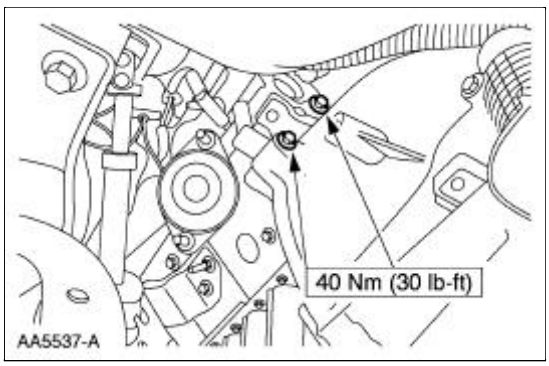
Vehicles equipped with manual transmission

7. Install the transmission. For additional information, refer to Section 308-03A .
8. Install the transmission oil filler tube.

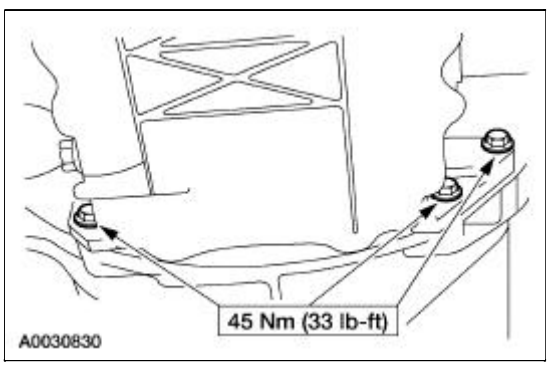


Vehicles equipped with automatic transmission

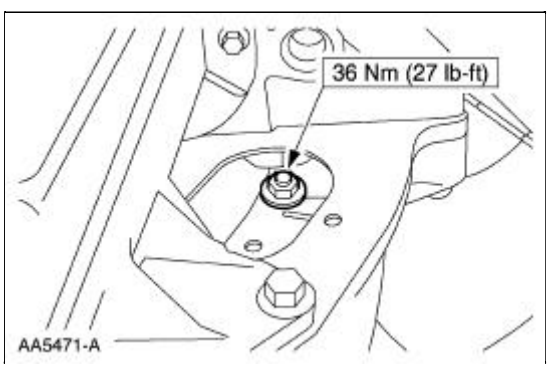
9. Install the five bellhousing upper bolts.



10. Install the bolts.

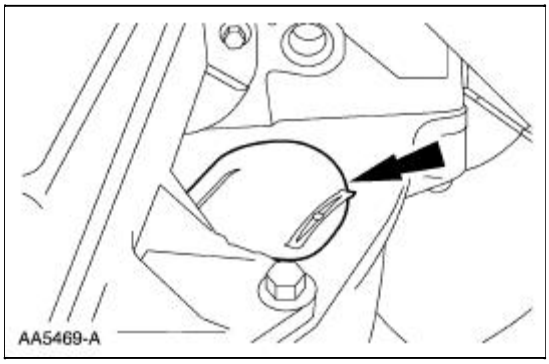


11. Install the four torque converter nuts.

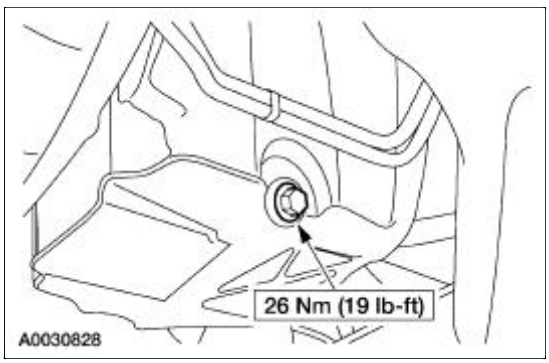


All vehicles

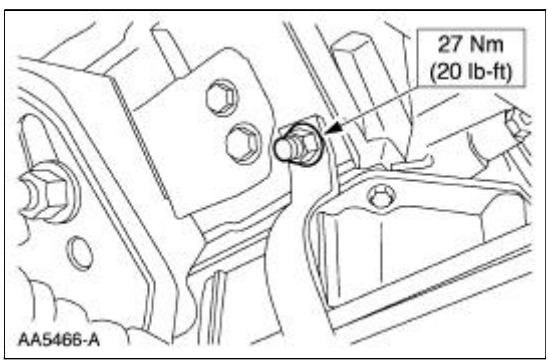
12. Install the access cover.



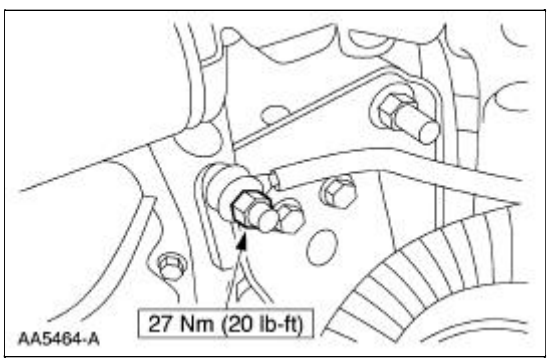
13. Install the oil pan drain plug.



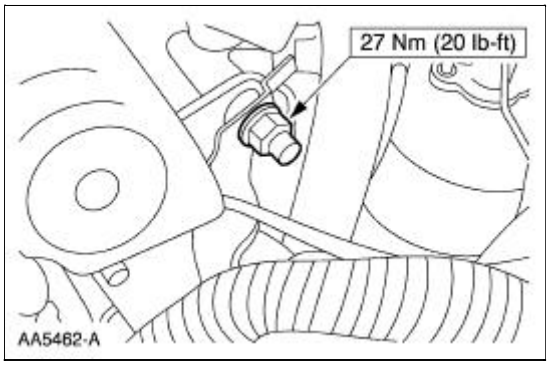
14. Install the bracket.



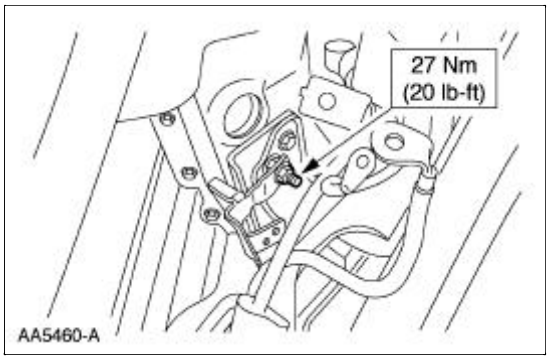
15. Connect the engine ground strap.



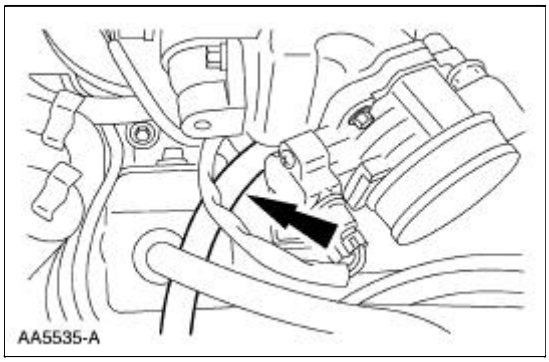
16. Install the bracket.



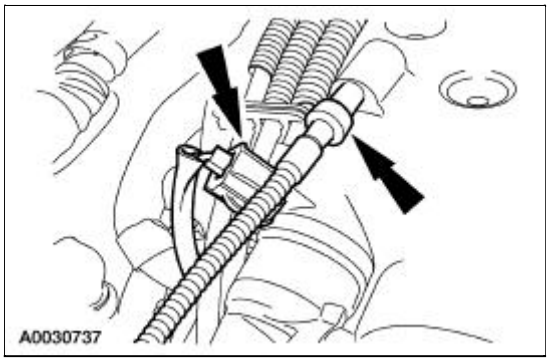
17. Install the bracket.



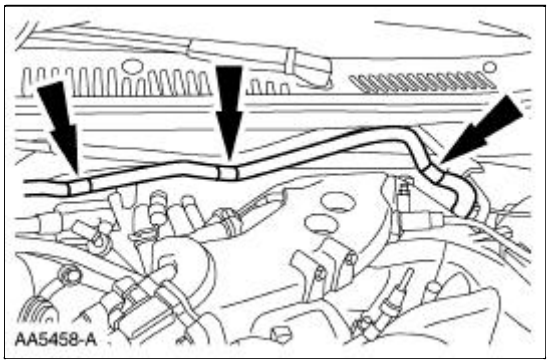
18. Install the dual converter Y-pipe. For additional information, refer to Section 309-00 .
19. Install the starter motor. For additional information, refer to Section 303-06 .
20. Lower the vehicle.
21. Connect the evaporative emissions (EVAP) return tube.



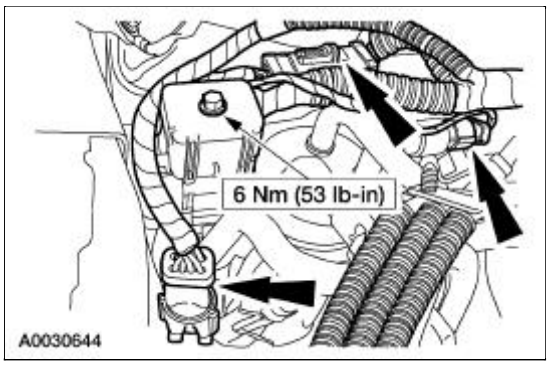
22. Connect the connector and vacuum tube.



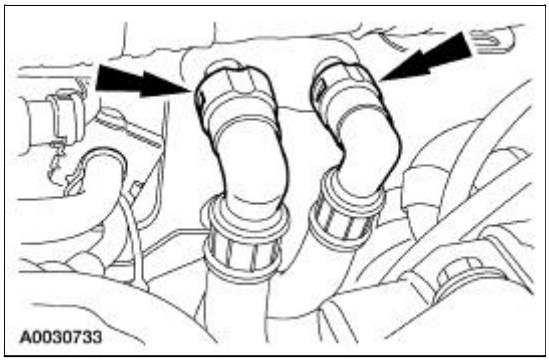
23. Position the wiring harness.



24. Connect the following connectors:
    - 42-pin electrical connector
    - 16-pin electrical connector
    - 8-pin electrical connector
    - A/C pressure switch

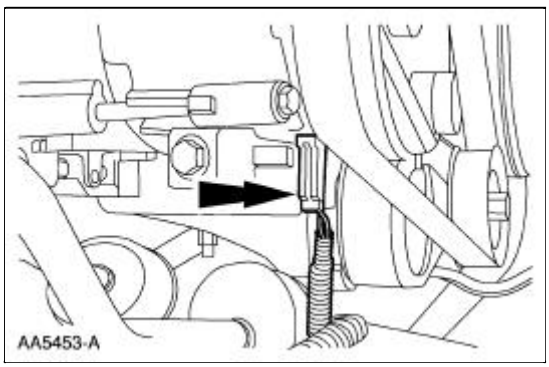


25. Connect the heater hoses.



26. Connect the fuel supply tube spring lock coupling. For additional information, refer to Section 310-00 .

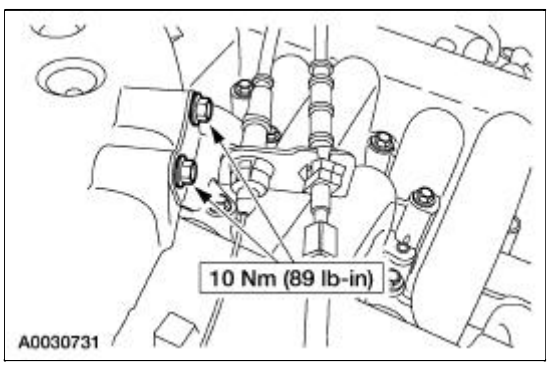
27. Connect the A/C compressor electrical connector.



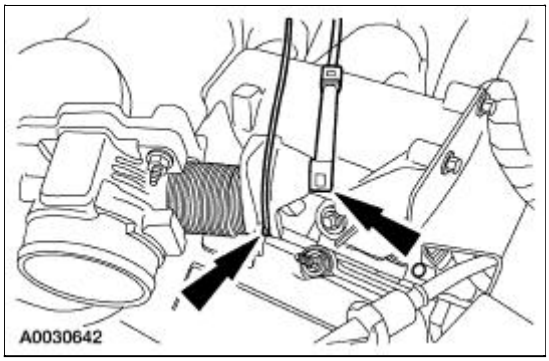
28. Connect the A/C manifold and tube. For additional information, refer to Section 412-03 .

29. Install the air cleaner outlet tube. For additional information, refer to Section 303-12 .

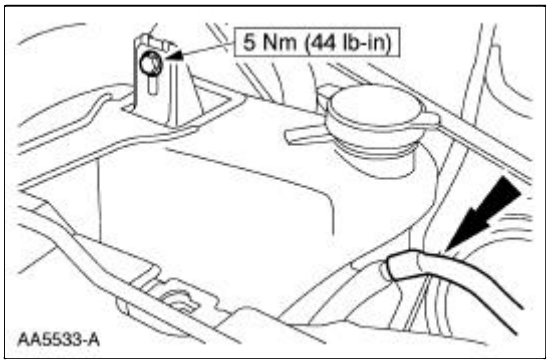
30. Install the accelerator cable bracket.



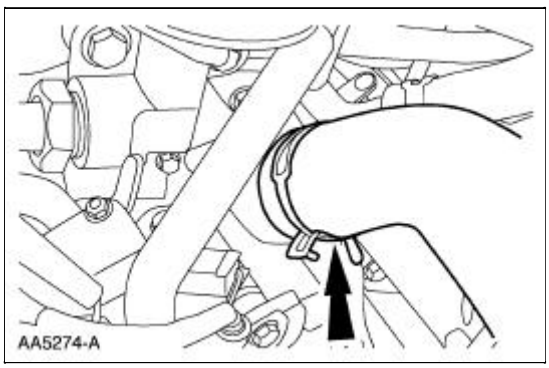
31. Connect the accelerator cable.



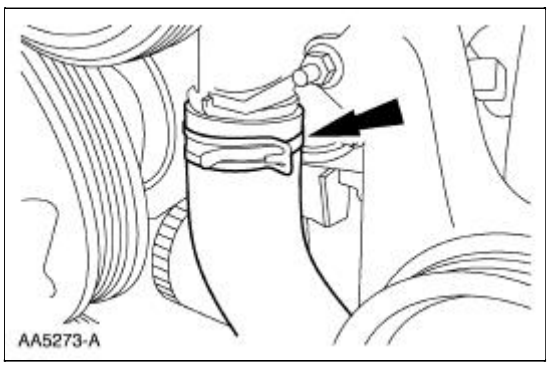
32. Install the radiator coolant recovery reservoir.



33. Connect the upper radiator hose.

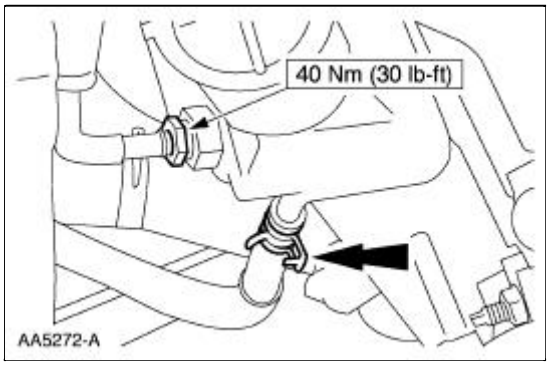


34. Connect the lower radiator hose.

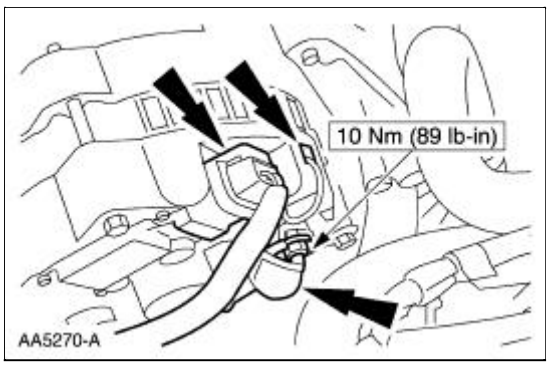


35. Connect the power steering pump.
    - Connect the power steering return hose.
    - Position the clamp.

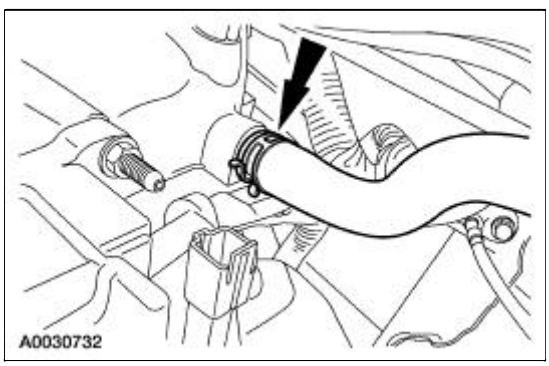
- Connect the power steering pressure tube.



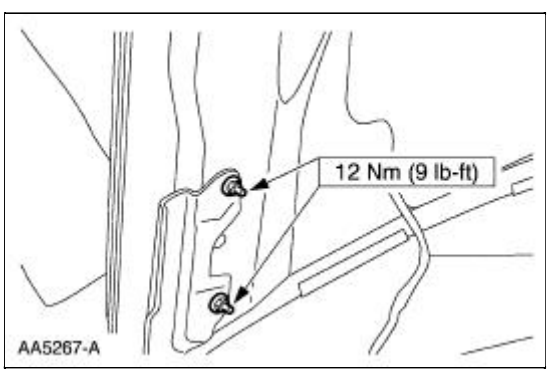
36. Connect the generator electrical connections.



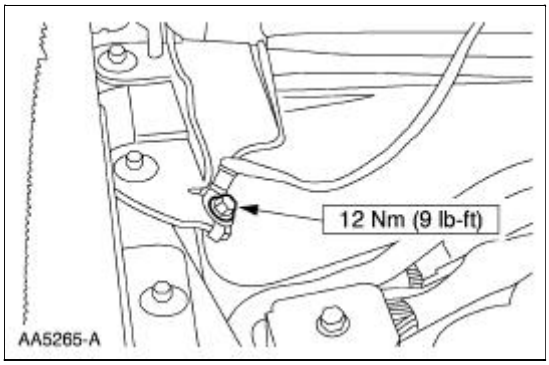
37. Connect the vacuum hose.



38. Install the hood.



39. Connect the hood ground strap.



40. Connect the battery negative cable. For additional information, refer to Section 414-01 .
41. Fill the engine with clean engine oil.
42. Fill the engine cooling system. For additional information, refer to Section 303-03A .
43. Recharge the A/C refrigerant system. For additional information, refer to Section 412-00 .
44. Fill and bleed the power steering system. For additional information, refer to Section 211-00 .